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ERRATA.

Page 74, note, line 1, for *was* read *is;*—p. 224, l. 4 from top, omit *superficial;*—p. 255, note, l. 9 from bottom, for *experiment* read *experiments;*—p. 259, note (*b*), for 33 read 34;—p. 274, note, bottom line, for *call* read *calls*.

CORRECTIONS AND ADDITIONS.

Prof. Henry's piece on the Aurora, p. 143, is taken from the report of the Regents of the University of the State of New York, to the Legislature of the same in 1832, which will soon be published.—Page 154, line 3 from the bottom, for *evening* read *evenings*.

THE

AMERICAN

JOURNAL OF SCIENCE, &c.

ART. I.—*Report* on the Geology of Massachusetts; examined under the direction of the Government of that State, during the years* 1830 *and* 1831; by EDWARD HITCHCOCK, Prof. of Chemistry and Natural History in Amherst College.

Part I.–*The Economical Geology of the State, with a Geological Map.*

TO HIS EXCELLENCY LEVI LINCOLN, ESQ. GOV. OF MASSACHUSETTS.

HAVING in a good measure executed the commission received from your Excellency, bearing date June 25, 1830, and directing me to make a geological examination of the State; I beg leave to present you with the first part of my Report.

My commission contemplates an exhibition of the different rock formations in the State, upon the map of the Commonwealth now in progress. But as it must necessarily be a period of considerable length before that work can be completed, I have constructed a small map from such materials as already exist, and delineated upon it the various kinds of rock that prevail in the State. These are shown by different colors and simple markings, easily understood by reference to the tablets on the lower part of the sheet.

To avoid confusion, I have placed on this map only so much of topography and geography, as was absolutely necessary. All the mountains and smaller rivers, with the boundaries of the towns, have been omitted; the center of each town being indicated by a small circle. For the same reason, I have employed only six different colors to mark the rocks; although more than twenty kinds are represented. But these, with a few exceptions, may be grouped togeth-

* Published in this Journal by consent of the government of Massachusetts, and intended to appear also in a separate form, and to be distributed among the members of the Legislature of the same State, about the time of its appearance in this work. It is, we believe, the first example in this country, of the geological survey of an entire State.

er, as they are in nature, in a few general divisions; the rocks in each division being so intimately related, that in an economical point of view, they may be regarded as varieties; although, in a scientific point of view, their differences are very important. All the rocks of a group have a common color on the map; and the different sorts are delineated by means of dots, crosses, circles, &c. In short, it has been a great object with me, so to simplify the map as to render it easily intelligible; while it exhibits all that is important to the practical man, as well as to the scientific enquirer. In the first part of my Report, I shall explain the different formations on the map, only so far as shall be necessary in illustrating our geology with reference to the useful arts; reserving the most important scientific remarks to a subsequent period.

It will be seen that I have extended the map a short distance into the adjoining states. This was done chiefly with a view to exhibit certain beds of ore, or other interesting minerals, which occur just beyond our limits. In a statistical point of view, these are nearly as important as those found within the State; and for this reason I shall notice such minerals in my Report.

In laying down the geology of the eastern part of Rhode Island, I have been much assisted by the communications of Col. Joseph G. Totten, of Newport. I am not without an apprehension that the region around Providence, particularly in Cumberland, will be found exhibited on the map somewhat incorrectly; as I had not time, when passing over it, to unravel entirely to my satisfaction, the peculiar intricacy of its geology. In laying down the geology of Berkshire, I have been greatly aided by the geological map of that county, published a few years since by Professor Dewey.

It has been my intention to give to each rock, precisely that relative extent on the map, which it occupies on the earth's surface. To do this with perfect accuracy, over an extent of more than seven thousand square miles, would be an almost endless task: especially when we recollect, that over the greater part of the surface, the rocks are covered by loose soil; so that in some instances, no rock in place shows itself to the traveller, for an extent of thirty or forty miles. In such cases, indeed, this stratum of sand, clay, and gravel, has been exhibited on the map under the name of diluvium. Still, under the most favorable circumstances for observation, the effort to give on a map the exact boundaries of each particular rock, must be regarded as only an approximation to the truth. Yet for all practical purposes, such approximation answers nearly as well as entire accuracy. If I have not misunderstood my commission and instructions, I was to have principally in view, in my examinations, practical utility; not neglecting, however, interesting geological facts, which have an important bearing upon science. Under such impressions I have gone over the State as rapidly as seemed to me consistent with the accomplishment of these main objects. In attempting to construct such a map as is appended, in the time that has been devoted to the survey, I am not without fears that I shall be thought to have aimed at too much; or that it will be supposed, little dependence can be placed upon it. Had I not previously become acquainted with the geology of nearly one half the State, from my own observation, or the published accounts of Professors Dewey, Webster, and the Danas, I should not have been able to accomplish this object, with any confidence in the correctness of the results. And as it is, I am aware that the map may need several minor alterations; though I feel quite confident of the correctness of its leading features. To obtain such corrections before the completion of the contemplated map of the State, is one strong inducement, thus early, to present this Report, and the accompanying map. For, should the Report in any way be made public, I shall hope that gentlemen of intelligence, in different parts of the State, will do me the favor to communicate any errors, or omissions which they may notice.

I propose to divide my Report into four parts. The *first part* will embrace the Economical Geology of the State; or an account of our rocks, soils, and minerals, that may be applied to useful purposes, and thus become sources of pecuniary profit.

The *second part* will embrace our Topographical Geology; or an account of the most interesting features of our scenery.

The *third part* will consist of our Scientific Geology; or an account of our rocks in their relation to science.

The *fourth part* will consist of catalogues "of the native mineralogical, botanical, and zoological productions of the Commonwealth," so far as they can be obtained; agreeably to a resolve of the Legislature, approved by your Excellency, February 2, 1831. Several gentlemen distinguished for their attainments in natural history, have generously offered to furnish these lists in those branches with which they are most familiar.

To illustrate the first and third parts of the Report, I have in accordance with directions from your Excellency, collected specimens of every variety of rock I could find in the Commonwealth; and in all cases where a rock is quarried, or might be quarried in several places, I have endeavored to obtain specimens from each locality. I have collected likewise, all the ores of importance found in the State, as well as the other simple minerals, which could be obtained without much difficulty or delay. I did not suppose that my instructions authorized me to be at much expense and trouble in procuring every rare mineral that has been described as occurring in the State; although this object may still be accomplished, if I have mistaken the intentions of the Government. The collection of specimens, which I have already made for the use of the Government, contains seven hundred and eighty individual pieces: and it is not yet completed; so that I shall not be able to forward it with this part of my Report. I do not know to what use the Government intends to devote this collection. But supposing it would be placed in some public situation, in order to exhibit to the citizens the geology and mineralogy of the State, I have endeavored to obtain from all the important quarries, and beds, whence stones are obtained for the purposes of architecture, or ornament, specimens which would fairly exhibit the qualities and value of each.

I have also in accordance with my instructions, endeavored to collect all the important varieties of rocks and minerals in the State, for the use of each of the colleges in the Commonwealth.

I cannot hope to complete more than the first part of my Report the present season: since some further points remain for investigation, before the third part can be properly finished.

In presenting a view of our economical geology, I shall first make a few remarks upon the different soils found in the state, as connected with the rocks over which they lie. And since it is an acknowledged fact, that all soils, had their origin in the disintegration, or decomposition of rocks, it might seem easy, at first thought, to ascertain the nature of the soil, if we do but know the integrant and constituent parts of the rock underneath it. Thus, in a soil lying above granite, we might expect that siliceous sand would be the predominant ingredient; next, clay with small quantities of potash, lime, magnesia and iron; because these are the constituents of granite. But several causes so modify soils, as to render all conclusions of this kind extremely uncertain. In the first place, the character of a soil depends more, in general, upon the nature and amount of the vegetable and animal matters it contains, than upon the nature of its other ingredients. And in the second place, the agency of running water, not merely of existing streams, but of mightier currents, to which the surface has been exposed in early times, has been powerful in modifying the loose coverings of the rocks. This aqueous agency has often covered one rock with the spoils of another; and sometimes mixed together the worn off fragments of half a dozen, and accumulated them in immense quantities in particular districts. These circumstances have rendered the subject under consideration an extremely difficult one; and very few general principles have yet been settled concerning it. Indeed, so far as I know, little attention has been given to it in this, or other countries. Still, there is such a thing as peculiarity of soil, occasioned by the peculiarity of the rock from which it principally proceeded. I shall notice any peculiarities of this kind, that have struck me, in the soils of Massachusetts; but I shall not enjoy the advantage of comparison, not having found more than one or two observations of a similar kind, made on the eastern continent. I shall begin with the stratum that lies above every other :—viz.

Alluvium.

In this part of my Report, I shall not enter into a systematic and minute description of the various formations represented on the accompanying map. Such description belongs more appropriately to the scientific part. I shall here describe the different strata only so far as is necessary to the particular purpose I have in view.

Alluvium is that fine loamy deposit, which is yearly forming from the sediment of running waters, chiefly by the inundations of rivers. It is made up, of course, of the finest and richest portions of every soil over which the waters have passed. Hence alluvial meadows have always been celebrated for their fertility. No extensive alluvial tracts occur in Massachusetts; although limited patches of this stratum exist not unfrequently along the banks of every stream, and with the adjoining elevated ground covered by wood and pasture, constitute not a few of the most productive farms in the State. Even where Deerfield river winds its way among the lofty and precipitous spurs of Hoosac mountain, which crowd so close upon the path as almost to throw it into the shade at noon-day, the traveller is sometimes agreeably surprised to see a luxuriant meadow open before him, rewarding the labors of some thrifty farmer. No alluvial tracts, however, have been thought of sufficient extent to deserve a place on the map, except one or two salt marshes a little northeast of Boston, and several meadows along the Connecticut, Deerfield, and Housatonic. Those of Longmeadow, Springfield, Northampton, Hadley, Hatfield, Deerfield, and Northfield, have long been celebrated for their unrivalled exuberance and beauty. Those in Great Barrington, and Sheffield are scarcely less inviting.

There is one variety of alluvial soil in this State, that deserves more attention from our agriculturalists. I refer to those numerous uncultivated swamps, which have for ages been the reservoirs of rich soil, that has been washed thither by rains and brooks. To reclaim them, does, indeed, require not a little labor and expense. But where the effort has been successful, the great and continued exuberance of these spots, has astonished and amply repaid the experimenter. Even in those cases where they cannot be reclaimed, which I believe to be few, they ought at least to be converted into manure, and spread again over those higher regions around, from which, by slow aqueous agency, they have been washed away. Very many of the most barren regions in the State, might, by this means, be clothed with fertility and plenty.

Diluvium.

This occupies more of the surface in Massachusetts than any other stratum. It is not generally distinguished from alluvium; but it is usually much coarser, being made up commonly of large pebbles, or rounded stones, mixed with sand and fragments of every size, which are often piled up in rounded hills to a considerable height; and under such circumstances, as preclude the probability that it could have resulted from existing streams. Indeed, it is spread over the highest mountains, wherever it could find a lodgment, and appears to have resulted from some powerful current of water, which, in early times, swept over the globe.

In a scientific point of view, this is one of the most interesting formations in the State; and in the proper place, I shall exhibit several facts respecting its relations and mode of occurrence. But in an agricultural point of view, it is the least interesting of all our strata; for of all the soils, it is the most unfriendly to rich vegetation. And as it is spread in a good measure over every kind of rock, it often prevents the formation of a good soil, from the decomposition of the rock. It is in general easily recognized in the most sterile places, in the form of low rounded hills, composed almost entirely of coarse pebbles, or cobble stones, and sometimes larger rounded masses of rock, called bowlders, mixed with coarse sand, and covered with a stinted vegetation. It was evidently deposited by currents rushing violently over the surface; since only the coarser materials, which were driven along, were left; while the finer particles were kept suspended by the agitation of the waters. Some varieties of this diluvium may, indeed, be converted into a soil of tolerable richness by manuring it abundantly, and clearing away the stones. And generally too, the rains that have fallen on it for thousands of years, have conveyed its finer particles to the bottom of the vallies and cavities, with which this formation abounds, and these being mixed with much vegetable decayed matter, a soil of good quality is formed. So that within the limits of this formation, much good land occurs. But these fertile spots ought perhaps rather to be denominated alluvion than diluvium.

Had diluvium been represented on the Map wherever it occurs, scarcely any other formation could have been exhibited. I have marked the region as diluvial, only where it occurs in such quantities, as almost entirely to conceal every other stratum. It is most abundant in the south east part of the State; the counties of Plymouth, Barnstable, Dukes, and Nantucket, being almost entirely overspread by it; so that in the three latter counties, I scarcely found any rocks that did not appear to have been broken up and moved from their original bed. Towards the extremity of Cape Cod, and on the island of Nantucket, this stratum is composed almost entirely of sand; which often constitutes those hills called *downs* or *dunes*, that travel inland by the action of winds, and do great mischief, by overrunning fertile spots; and on the eastern continent, by burying even villages and cities. The most effectual remedy that nature has provided against these encroachments, seems to be Beach Grass ;—(*Arundo arenaria*, Lin. *Psamma arenaria*, Beauv.) which is able, not only to fix itself on the most barren ridge of sand, but also in time to fix the sand itself.

Diluvial tracts of considerable extent, exist in the county of Norfolk; in the Connecticut valley, and along the western base of Hoosac Mountain. None of them however are noticed on the Map. Most of the islands in Boston Harbor, are thus colored; also Plum island in Essex county, and a part of Malden and Chelsea.

Tertiary Formations.

The only difference between these and diluvium, is, that in diluvium, the sand, pebbles, and clay, are confusedly mixed together; but in the tertiary formations, these materials are arranged in regular, and generally, in horizontal layers, one above another. Hence, when the sandy stratum happens to lie uppermost, the soil will be too sandy; but if this be worn away, so that the clay lies at the surface, the soil will be too argillaceous; or if the gravel stratum be exposed, the soil cannot be distinguished from diluvium. All these varieties of soil thus produced, may be seen in the valley of the Connecticut; where exists the most extensive tertiary formation in the State; extending nearly to Middletown in Connecticut. Upon the whole, there is little to choose in an agricultural point of view, between those tertiary formations that occur in Massachusetts, and our diluvium, although in England, some of these formations, that embrace beds of loam and marl, are very productive. But it is doubtful whether our tertiary formations are identical with any in Europe. At any rate, ours contain no marl, and very little loam; and where the sand is uppermost, much of the soil corresponds to those unimproved and unimprovable tracts, that occur in the immediate vicinity of the English metropolis—composed of what is locally denominated, bagshot sand. Where the clay predominates, however, cultivation and proper manure produce a valuable soil. Of this description are the small tertiary patches on the Map in the vicinity of Boston. There, in fact, the clay near the surface, appears generally to have been disturbed, and to be mixed with loam; and it is doubtful whether they ought not rather to have been colored as diluvium, than as tertiary. It ought also to be remarked, that the sandy plains of the Connecticut river, are very congenial to the growth of rye, and are very easy to cultivate.

New Red Sandstone.

This is found along Connecticut river. Although composed of numerous varieties of rock, the prevailing color is red; and the reddest varieties are most liable to decomposition; viz. a red slate and a red sandstone. No rock in the State disintegrates so easily as this; nor has any other so impressed its peculiar characters upon the soil. In Long Meadow, Wilbraham, Southwick, West Springfield, Easthampton, and Greenfield, it is common to see tracts of considerable extent, where the diluvium and tertiary are chiefly swept away, exhibiting that reddish aspect, which in England, is so characteristic of soils derived from this formation. The Devonshire butchers, it is said, are able to distinguish the sheep raised on this soil, by the color of their fleece; and many local names in that country, originated from the same circumstance; such as Rougemont Castle, in Exeter; Red Hill and Redford, in Somersetshire; Red Brook, in Gloucestershire; Red Mire, Rotherham, &c. in Yorkshire.

The new red sandstone is said to be associated with some of the most fertile land in England; especially that variety of the rock denominated red marle. It is distinguished for the excellence of its wheat, barley, beans and cider. The sand resulting from the decomposition of the coarser varieties of the rock, produces most of the rye grown in England. In that country, however, this formation contains not a little limestone, either in beds, or impregnating the sandstone. But in Massachusetts, the lime is almost entirely wanting: and hence probably it affords a soil inferior to that produced by the English rock. Still, with us its soil is of a superior quality. Its poorer varieties are excellent for rye. It is also peculiarly well adapted for fruit. The grass grown upon it is of a superior quality; and it affords excellent pasture. The establishment of the Shakers in Enfield, Ct., exhibits a favorable example of the productiveness of this soil, when under a good cultivation. The black, white, and red oaks, with pignut hickory, chesnut, and soft maple, (*Acer rubrum*,) are the forest trees most naturally produced upon this soil.

Argillaceous and Flinty Slate and Graywacke.

The flinty slate is a variety of the argillaceous or roofing slate, which has been indurated, and it occurs only in small quantity at Nahant. The argillaceous slate in the vicinity of Boston, is intimately connected with the graywacke, and probably ought to be considered only as a variety of that rock. It is considerably different from the argillaceous slate of Worcester, Franklin and Berkshire counties. Every variety, however, furnishes by decomposition, a dark colored soil, which, although somewhat apt to be cold, is capable of being made very fertile. The central parts of Quincy, exhibit a favorable example of the soil lying above this rock. The range in Worcester county, is almost every where overspread with diluvium, and in Franklin and Berkshire, this rock is so limited in extent, as not very strikingly to develop the peculiarities of its superincumbent soil. Professor Dewey, however, says, that in Berkshire "the argillaceous district is more fertile and productive than any other portion of the section, except the alluvial."

Numerous varieties of rock, both in color and composition, are associated under the term graywacke: from the fine dark colored shale or slate, containing the anthracite coal of Rhode Island, to the coarse conglomerate, or plum pudding stone, of Roxbury, Dorchester, Dighton, Somerset, and Swansey. Most of these varieties, however, appear to furnish a soil of good quality, and sometimes of superior fertility. The island of Rhode Island exhibits the superiority of the soil of this formation, to that of several other islands that surround it. As we proceed northerly, the great quantities of diluvium spread over the surface, obliterate, or greatly modify the soil peculiar to the formation. But in Dorchester, Roxbury, Brooklyn, Brighton, and Newton, it is exhibited to great advantage; presenting the finest examples of exuberant farms and gardens in the Commonwealth; although we must not forget the very superior cultivation that has been bestowed upon that part of the State. Still, such luxuriance as we there witness—such fine fruit especially—could not be produced without a soil naturally excellent.

Iron Ore.

No ore except iron occurs in sufficient quantity in the State to deserve notice in an agricultural point of view. In the west part of Worcester County, the soil for a width of several miles across the whole State, is so highly impregnated with the oxide of iron, as to receive from it a very deep tinge of what is called *iron rust.* This is particularly the case in the low grounds; where are frequently found beds of bog ore. I do not know very definitely the effect of this iron upon vegetation; but judging from the general excellence of the farms in the Brookfields, Sturbridge, Hardwick, New Braintree, Barre, Hubbardston, &c., I should presume it to be good. Certainly it cannot be injurious; for no part of the County exceeds the towns just named in the appearance of its farming interest; and nearly all the County, as may be seen by the map, is of one formation. It would be an interesting problem, which in that county can be solved, to determine the precise influence of a soil highly ferruginous upon vegetation.

Steatite, Serpentine, Scapolite Rock, Limestone.

The next rocks, in an ascending order upon the tablets attached to the map, are steatite or soapstone, serpentine and scapolite rock. But they are of such limited extent as to deserve no notice in this connection. The next rock, namely limestone, is found only in Berkshire County, in quantities sufficient to modify the soil over much extent of surface. But in that county it occupies most of the vallies; while the mountains are chiefly mica slate. And the fertility of these vallies is a striking evidence of the good influence of disintegrated and decomposing carbonate of lime upon the soil. Indeed, I believe that it is generally thought in Europe, that soils of this description are more productive than any other, except rich alluvions. And I apprehend that one of the greatest deficiencies in the soil of the principal part of Massachusetts, is the absence of lime. Probably if our farmers could procure this article at a moderate expense, its application as a manure would amply reward them for their trouble. Limestone that contains much magnesia, is, indeed, said to be injurious to vegetation, unless it be upon peaty soil, or soil containing much vegetable matter; and this limestone is common in Berkshire County. But it occurs there in beds, alternating with the pure carbonate of lime, and I apprehend rarely produces any bad effect.

Quartz Rock.

It will be seen by the map that one variety of this rock is associated with mica slate, and another with gneiss; so intimately, indeed, that its agricultural character may be considered the same as that of these rocks. When it occurs in the state of pure quartz, it is so little acted upon by the common decomposing agents, such as air, heat and moisture, as to exert little or no influence upon the superincumbent soil; except in the town of Cheshire, where it produces a pure white sand.

Chlorite Slate, Talcose Slate, Mica Slate.

The first of these rocks occupies too little space to deserve any notice in respect to the soil resulting from it. The second is in general a mere variety of mica slate, talc taking the place of mica, or being superadded to it. Where the talcose slate, however, is most pure, so as in fact to be little else but slaty talc, with more or less quartz, the soil which its decomposition produces, is decidedly inferior to that resulting from mica slate; and probably this is owing to the large quantity of magnesia which talc contains.

Mica slate produces a soil of a medium quality. Some varieties of it underlie tracts of superior quality. But the most extensive tract of mica slate in Massachusetts, consists of the high and mountainous region west of Connecticut river: so that it is difficult to compare the soil lying over it, with that of formations at a lower level. The deep ravines, however, so common in the mica slate, furnish many very fertile, though limited patches of ground; while the mountain sides are very superior for grazing.

Hornblende Slate, Gneiss.

Gneiss, which differs from granite only in having a slaty structure, occupies more of the surface of the State than any other rock. It sometimes takes into its composition the black mineral called hornblende; even losing its common ingredients; and then it is denominated Hornblende Slate. Sometimes the quartz so greatly predominates over the other ingredients, that it is properly called quartz rock.

The soil resulting from the decomposition of gneiss is so well marked, as not to be easily mistaken by an experienced eye. Its predominant ingredient is a rather fine whitish sand; and sometimes beds of extremely pure sand are found in it; as in Pelham and Shutesbury. Indeed, the appearance of the soil from gneiss, indicates uncommon poverty and sterility. But facts do not correspond to this anticipation; for in no part of the State do we find finer looking farms, or the appearance of more thrift and independence among their occupants, than in the region where gneiss prevails: I refer chiefly to Worcester County, most of which is based on this rock. The western part of the range, however, embracing the eastern part of Franklin, Hampshire and Hampden Counties, is in general characterized by a rather barren soil. But this region is more elevated than the surface farther east. Where it is not so high, as in Monson and Brimfield, we find the same appearance of fertility as in the towns farther to the east. It is a question worthy of attention, however, how far the soil from our gneiss-rock may owe its agricultural character to the iron that so generally accompanies this rock. Certainly the iron gives it an appearance of sterility which does not belong to it.

Greenstone.

This is one of the varieties of rock embraced under the general term *trap rock.* The variety most common in Europe is basalt: and the soil produced by its decomposition is said to be of a superior quality. The greenstone of Massachusetts, however, except some of its rarer varieties, is but little acted upon by ordinary decomposing and disintegrating agents; and is proverbially one of our hardest and most indestructible rocks. Hence the soil that covers it is generally quite scanty. It is, however, very peculiar; and we find upon our greenstone ridges, quite a number of plants, shrubs, and trees, that are not found, except rarely, upon the other formations. The eastern part of the County of Essex is in a great measure composed of greenstone; and its superior agricultural character, in general, produces a favorable opinion as to the influence of this rock upon the soil, though very much must be imputed to good management. This formation in the Connecticut valley furnishes but little arable land, and that of rather a sterile character.

Porphyry and Compact Feldspar.

These rocks differ but little in an agricultural point of view. They are of quite limited extent and are decidedly the hardest and most unyielding of all our rocks. They occupy the greater part of the surface, and the scanty soil that has formed a lodgment in their inequalities, is not of the first rate character.

Sienite and Granite.

Sienite is intermediate in its characters between greenstone and granite, although most commonly it is only a variety of granite. Both rocks are little liable to decomposition, and occupy a large porportion of the surface with their naked and rugged projections. Still, the soil found among them, particularly on the granite, is generally of a superior character, probably from the fact that most of it must have been derived from decomposed vegetable and animal matter. Hence it is usually of a dark color and fine texture, and not coarse and sandy like the soil above the granites of Europe, that more easily suffer decomposition.

Should the preceding cursory remarks be the means of exciting the attention of intelligent agriculturists, to the connexion between rocks and soils, an important object will be attained. I have said enough to show that almost all known varieties of soil exist in Massachusetts. But much improvement remains to be made in our agricultural concerns, before the excellencies of our soil are fully developed. It is but a moderate estimate to say, that the general adoption of an enlightened system of cultivation, would, in a few years, double the produce and the value of our improvable lands. That is to say, such would be the speedy result, if all our farmers were to manage their lands as a few now do.

USEFUL ROCKS AND MINERALS IN THE STATE.

I shall next proceed to give an account of those rocks and mineral subtances found in the State, which have been, or may be useful in the arts, and are consequently objects of pecuniary importance. Those that are employed for architectural or ornamental purposes, first claim attention; because the state is peculiarly rich in treasures of this kind. It will be easy to see, by a reference to the Map, how extensive are the formations from which they are derived; although it must not be concluded that every part of a formation will furnish materials of equal value for economical purposes.

Granite and Sienite.

Much confusion has arisen in the application of these terms. They were originally applied to designate rocks very different, if not in composition, yet in their geological relations. But most of the rock that is generally described as sienite, is a variety of granite. This is certainly the case in Massachusetts. Wherever the granite admits hornblende into its composition, I have considered it as sienite; and not unfrequently the hornblende constitutes the principal ingredient; taking the place, more or less, of the quartz and mica, so as to form a compound of hornblende and feldspar. This compound forms some of the most beautiful varieties of sienite, though extremely hard to work for architectural purposes. But not a little granite that contains no hornblende goes by the name of sienite. Thus, much of the Quincy granite is wanting in hornblende; but being almost destitute of mica, and having the close aspect of sienite, it is called indifferently by either name.

The variety in the composition, color and hardness of these rocks in Massachusetts, is almost endless. The quartz and feldspar are commonly white, yellowish and gray; the latter not unfrequently flesh colored: the mica is very often black, but sometimes of a silver color. When the quartz prevails, the rock is easily broken, but hornblende renders it tough. The predominance of feldspar generally gives the rock a more lively white color and renders it rather easier to work. But I shall not attempt to describe particularly all the varieties of these rocks that occur in the State. An inspection of the specimens which I have collected, will at once give an idea of the kinds obtained at the principal quarries, and of numerous other varieties which I have met with in different localities.

The very coarse varieties of granite, which are found in some parts of the State, do by no means furnish a good building stone: indeed, some of them hardly serve for common walls. Much of the granite in the vicinity of the Connecticut river is of this description; as also a considerable portion of the range which extends from Southboro' to Andover; particularly along its northwestern limits. But most of the granite in the eastern part of the State, is of so fine a texture, as to answer admirably for architecture and other economical purposes. Along with sienite, it extends around Boston, running in a curvilinear direction at the distance of fifteen or twenty miles. From Cohasset to Quincy, at the southern extremity of the curve, and from the end of Cape Ann to Salem, on the north, the formation is most fully developed, and is there quarried extensively. The Quincy quarries are probably the best and most generally known; and few citizens of the State are unacquainted with the rock thence obtained, now so extensively used in Boston and elsewhere. The quantities which those quarries (or rather mountains) will furnish, are incalculably great. One railroad, as is well known, has been used for several years to convey the granite from the quarry to Neponset river, a distance of three miles. It is thought, however, that the granite has not reached its *minimum* price. Yet even now, Boston is almost as much distinguished for its granite structures, as the metropolis of the Russian Empire.

Some of the granite obtained on the north of Boston, cannot be distinguished from that of Quincy. I observed the resemblance most strongly in Danvers and Lynnfield. At the former place it is quarried, and fine blocks are obtained. Extensive quarries are also opened in the north side of Cape Ann, in Gloucester. The rock here resembles that of Quincy; but it is generally harder and of a lighter color. At these quarries no railroad (except one of a few rods in length) is necessary to transport the rock to the sea-side; since vessels can approach very near the spot. And, since the demand for this rock must increase, in our country, for many years to come, and Cape Ann is little else than a vast block of it, it seems to me that it must be regarded as a substantial treasure to that part of the State,—far more valuable than a mine of the precious metals. At Squam, in Gloucester, I was informed that blocks of granite had sometimes been split out sixty feet in length; indeed, I saw the face of a ledge from which they had been detached.

At Fall river, in Troy, which lies upon Taunton river, are other extensive and interesting granite quarries. This granite, as the Map will show, is connected with the Quincy range above described. Yet the greater part of the granite in Plymouth and Bristol is coarser than that of Quincy and Gloucester, and more liable to decomposition. But no rock can be finer for architectural purposes than the granite of Troy: and immense quantities have been obtained from this locality. The large manufactories at Fall river are built of it, as is also Fort Adams at Newport, Rhode Island. The feldspar of this rock is a mixture of the flesh red and light green varieties; the former predominating: the quartz is light gray, and the mica, usually black. It works easily, and has a lighter and more lively appearance than Quincy granite. Blocks of this granite have been split out from fifty to sixty feet long, as the sign-post at one of the public houses at Fall River, will attest: it consists of a single block. The contiguity of this granite to water transportation, will always render it peculiarly valuable.

The granite range extending from Cohasset and Quincy, through Randolph, Stoughton, Foxborough, &c. into Rhode Island, affords much valuable stone for architectural purposes; and it is wrought more or less in every town through which it passes. About two and a half miles to the west of Providence, (R. I.) it is quarried; and thence were obtained the beautiful and magnificent pillars in front of the Arcade in that place.

That part of this extensive deposit of granite, which is fully developed a little south west of Dedham, furnishes some beautiful varieties of stone. No better example can be referred to, than the elegant pillars of the Court House in Dedham. This granite is very fine grained, and so white, that at a short distance it cannot be distinguished from white marble. The pillars just named were obtained from some large bowlders near the dividing line between Dover and Medfield.

The stone used in Boston, under the name of Chelmsford granite, is found in a range of this rock, not connected with the deposit that has been described above. Nor does it come from Chelmsford; but from Westford and Tyngsborough. In the latter place, it is obtained chiefly from bowlder stones; but ledges are quarried in Westford. I do not know why it has been called Chelmsford granite, unless from the fact that large quantities are carried to Lowell, (formerly a part of Chelmsford,) to be wrought. This rock is pure granite, with no hornblende; and being homogeneous and compact in its texture, it furnishes an elegant stone. Good examples of it may be seen in the pillars of the United States Bank, and in the Market House in Boston. These were from Westford.

Four miles north of Lowell, a quarry of this granite has been opened, in Pelham, (N. H.) Blocks may be obtained from this place of any length under thirty feet. It is a very fine variety, is much used, and appears superior to the Chelmsford granite.

The Westford and Pelham granite is connected with an imperfect kind of mica slate, in which it seems to form beds, or large protruding masses. In the same mica slate at Fitchburg, a little south of the village, is a large hill of the same kind of granite. This is quarried, though not extensively, on account of the little demand for the stone. This single hill, 300 feet high, and nearly a mile in circumference at its base, might furnish enough to supply the whole State for centuries. Some of it, however, is too coarse for architecture.

The manner in which the granite is usually split out of the quarries is this. A number of holes, of a quadrangular form, a little more than an inch wide, and two or three inches deep, are drilled into the rock, at intervals of a few inches, in the direction in which it is wished to separate the mass. Iron wedges, having cases of sheet iron, are then driven at the same time, and with equal force, into those cavities; and so prodigious is the power thus exerted, that masses of ten, twenty, thirty, and even fifty and sixty feet long, and sometimes half as many wide, are separated. These may be subdivided in any direction desired; and it is common to see masses thus split, till their sides are less than a foot wide, and their length from ten to twenty feet. In this state they are often employed as posts for fences.

Respecting the price of the granite from the quarries that have been described, I have not been able to obtain much information. At Fitchburg, I was told that it was sold at the quarries, well dressed, at forty cents the superficial foot; and at Squam, at forty-five cents.

The cost of hammering and fine dressing granite in Boston, in the style of the Tremont House, I have been credibly informed, is about thirty cents the superficial foot. Ordinary work, however, is from twenty-five to thirty cents; and not unfrequently, even as low as twenty cents.

Concord and Hallowell granite cost about fifty cents per foot in Boston; but are now little used.

Posts for store-fronts, cost about thirty-four cents per foot in Boston. The columns of the Hospital were obtained for about one dollar per foot.

To show how rapidly the price of granite has fallen, I would state on the authority of a respectable architect in Boston, that the cost of the blocks of the Quincy granite for the Bunker Hill monument, delivered at Charlestown in a rough state, was thirteen cents, three mills, per foot; and the cost of the unhewn stone for the church built last year in Bowdoin street, Boston, was fifteen cents: but six years before, the rough Quincy granite, for the United States' Branch Bank, cost two dollars per foot.

I have now given an account of the most extensive and important quarries of granite and sienite, in the eastern part of the State. Granite is wrought more or less, however, not merely in all the towns through which its ranges pass, but also in other places, in their vicinity; large blocks of it having been removed thither by diluvial action in former times.

Although the granite in general, in the vicinity of the Connecticut river, is too coarse for architectural uses; yet in Hampshire county are several beds of a superior quality. Perhaps the best is found in Williamsburgh, a few miles from Northampton. This rock, (some of which may be seen in the front of a few buildings in Northampton,) very much resembles the granite found in the vicinity of Dedham, and yields in beauty and value to none in the State. It exists in abundance in Northampton, Whately and Williamsburgh; but has yet been quarried only on a very limited scale.

On the east side of the Connecticut, a very beautiful sienitic granite exists in Belchertown; in which the mica, when the hornblende is wanting, is very black. It is not surpassed in elegance by any rock in the State: but it has not as yet, to my knowledge, been quarried at all. Indeed, very little real granite is employed in the middle or western parts of the State.

This sketch of the granite of Massachusetts, although brief, is sufficient to show that we have a great number of varieties, and an exhaustless quantity, of the most valuable material for durable and elegant architecture. Numerous varieties not mentioned above, which have fallen under my observation, either in ledges or loose blocks, will be found in the collection of specimens; and some of these are peculiarly beautiful. Numerous other varieties have doubtless escaped my observation. Indeed, we may safely assert, that no part of the world is better furnished with this useful and indestructible rock.

Gneiss.

This rock is commonly known under the name of granite; and, indeed, it is composed of the same materials; but in the gneiss, the structure of the rock is slaty, and it splits in one direction better than in others; yet this slaty structure is often hardly perceptible, even in wrought specimens; and hence for all architectural and economical purposes, the distinction of granite and gneiss is of small importance; though of much consequence in respect to the science of Geology.

The quarries of gneiss in Massachusetts are perhaps even more numerous than those of granite, though not in general so extensively wrought. It forms an admirable building stone; and is in no respect, that I know of, inferior to granite; while the facility with which it cleaves in one direction, renders it easier to get out and dress; so that it can be afforded at a less price. Accordingly we find that a large proportion of the better class of buildings, in the extensive portion of the central part of the State, where this rock prevails, are underpinned by wrought blocks of it. Its fissile character also renders it an excellent material for common stone walls and flagging stones. The same property enables the quarry-man to split out layers of it of almost any size, and only a few inches in thicknesss: and their surface is generally so even, as to require but little dressing. Hence it is very common to see such large stones of this description in front of very many of our churches and other public buildings.

It is a curious fact, that in Europe gneiss seems to have been applied to no useful purpose. One of the latest geological writers in Great Britain says, that "this schistose (slaty) body serves no particular purpose in the arts of life."* This rock appears to be more perfectly developed in our country than in Europe. There it seems chiefly to consist of that variety, not uncommon here, in which the layers are so contorted and irregular as to prevent its splitting into parallel planes.

The western part of Worcester County, and the eastern part of Hampden, Hampshire, and Franklin Counties, afford the best quarries of gneiss. That branch of the Worcester range extending into Middlesex County, and the range in Berkshire County, do not furnish so good specimens for architecture, though by no means devoid of interest in this respect.

The quarries of gneiss that are most extensively wrought, and furnish the best stone, are situated in the following towns: Wilbraham, Pelham, Monson, Montague, Dudley, Millbury, Westborough, Boylston and Uxbridge. Much of the stone at these quarries can hardly be distinguished from granite, even by the geologist. The Millbury

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* Ure's Geology, p. 100.

gneiss, for instance, is very much used in Worcester, and does not there present any appearance of stratification, and very little of a slaty structure: while the granite, that is quarried in the east part of Worcester, is distinctly stratified; and would probably be called gneiss, by most persons, rather than the Millbury rock. The Worcester granite, however, affords almost the only example of stratification in that rock in this State.

At these gneiss quarries it is easy to obtain blocks from ten to twenty feet long, which are only a few inches thick. At Dudley, I was told that narrow slabs of this rock, such as would answer for posts, or side walks, could be split out, and delivered in the center of the town, for four cents per foot.

Greenstone.

This is one of the most enduring of all rocks; but it is usually so much divided by irregular seams, into small and shapeless blocks, that it is but little employed, either in the construction of houses, or walls. Its dark color, also, renders it less acceptable than granite or limestone. Still it is beginning to be used for building houses, in its unaltered state. The irregular blocks may be so laid with white mortar, especially in the Gothic style of building, as to form a picturesque and pleasing structure. The Episcopal Church, in the city of New Haven, (Conn.) presents a good example of this kind of architecture.

Hornblende Slate.

I do not recollect to have seen this rock employed in Massachusetts for any useful purpose, except for the construction of common stone walls. But I have noticed some very fine samples of it in the flagging of the side walks of New Haven, obtained, I presume, in Connecticut, from the same range that passes through Monson, Ware, &c. in Massachusetts.

Porphyry.

This term, as it is employed in the arts, embraces several varieties of rock not designated by its strict geological sense. Although upon the Map, I have included in the term, only the porphyry of geologists, yet in this place, I shall describe all those compounds occurring among us, which have been denominated porphyry in the arts.

The first and most extensive of these, is the genuine feldspar porphyry, represented on the Map in large quantities in the towns of

Medford, Malden, Chelsea and Lynn, on the north of Boston; and in Needham, Milton and Braintree, on the south. This is the oldest and most enduring of the porphyries, and, indeed, the hardest of the rocks. Its basis is generally compact feldspar, reduced to a homogeneous paste, and of various colors; as light purple, red of various shades, brownish black, and greenish gray. The imbedded crystals are either feldspar, or quartz, alone, or existing together in the same rock: and their colors are very various, though more usually white or gray. By these mixtures porphyries are produced, rivalling in beauty the best antique porphyry. This rock is polished with so great difficulty, that it is rarely used in our country, either for ornamental or useful purposes. But it would be strange if an increase of wealth and refinement should not create some demand for so elegant and enduring a rock. Whenever this shall happen, the vicinity of Boston will furnish every variety that can be desired, and in blocks large enough for any purpose.

The porphyry range on the north of Boston, is most perfect in its characters, and in the greatest abundance at any one place; although the southern range spreads over a greater extent of surface. In Lynn, and some other towns, I have observed blocks of porphyry that were brecciated—that is, they were composed of angular fragments of porphyry reunited. This furnishes a beautiful variety for polishing.

Sienitic Porphyry.

When sienite contains crystals of feldspar imbedded in the mass, it is said to be porphyritic; and some varieties of this rock in the eastern part of the State are very elegant. Essex County produces some of the finest specimens, particularly Cape Ann. Sometimes the imbedded crystals of feldspar are white, sometimes flesh-colored, and in Gloucester, I found a rock in which they were of a very rich bronze color. These sienitic porphyries are extremely elegant when polished; but I am not aware that they are employed at all for ornamental purposes, in this country.

Porphyritic Greenstone.

The ingredients of greenstone are often not easily distinguished from each other by the naked eye; and when, in such a case, the rock contains disseminated crystals of feldspar, it becomes porphyritic. If these crystals are greenish white, and the base blackish green, the rock is the *green porphyry* of the ancients. In Dorchester, Brookline, and Roxbury, according to the Messrs. Danas, it occurs in rounded masses; and in small quantity, in veins, at Marblehead. But I have found it in large veins traversing sienite, at Sandy Bay, on the north-east side of Cape Ann. Large blocks might be thence obtained; and if polished, it would constitute a truly splendid ornament for the interior of a church, or a private dwelling.

If the feldspar crystals be black, or greyish black, the rock is the superb *black porphyry* of the ancients. This occurs in small beds and rolled masses in Charlestown, and in veins of greenstone at Marblehead. I found it, also, in a rolled mass, in the west part of Ipswich; the feldspar being of a jet black, and of a high lustre. Polished specimens would vie in elegance, to say the least, with the green porphyry.

The hornblende slate in various parts of the State, but particularly in the region of the Connecticut river, is frequently porphyritic; and exceedingly resembles porphyritic greenstone; being, in fact, composed of the same ingredients; and differing only in its slaty structure, and in the more distinctly crystalline character of the hornblende. The disseminated crystals of feldspar are usually white. In Canton and Easton, they are sometimes the compact variety, yet retaining their form perfectly.

The magnetic iron ore in Cumberland, (R. I.) is profusely sprinkled with crystals of feldspar; and would doubtless form no mean substitute for green or black porphyry.

Quartz Rock.

When this rock occurs pure, it can hardly be employed in architecture of any kind, on account of its breaking into fragments so extremely irregular. But when it takes a small proportion of mica into its composition, it is often divided, with mathematical precision, into layers of convenient thickness for building. The best quarry of this kind that I know of, is in the west part of Washington, Berkshire County, about three miles south-east of Pittsfield village. The layers vary in thickness from one or two inches, to one or two feet; thus affording materials for fine flagging stone, as also for walls and underpinning. The quantity of this rock at the quarry is very great.

Although quartz rock is usually, of all others, most easily affected by heat, yet that variety from the quarry in Washington, is remarkable for its power of resisting heat; and it is here employed for the hearths and walls of furnaces. Prof. Dewey says that he has "seen this stone after it has sustained the highest heat of the furnace for months, and found its surface merely glazed by the high temperature." It was transported to the iron works in Bennington, Vt. until a similar rock was discovered in that town. It occurs also in Williamstown. What peculiarity this rock possesses, that renders it able to resist a high temperature, I do not know.

Another valuable variety of quartz rock is found near the quarry above mentioned. But its use, as well as that of another variety in Cheshire, will be noticed subsequently.

Mica Slate.

This rock is generally more uneven or tortuous in the structure of its layers, than any rock in the State. But, like gneiss, its layers are sometimes remarkable for their regularity. It then forms an admirable stone for flagging, for hearths, and for situations where there is an exposure to a moderate degree of heat. The variety that occurs in Goshen and Chesterfield, Hampshire county, is perhaps the best in the State for these purposes; and in these places, particularly in Goshen, it is quarried to a considerable extent. In some cases this rock approaches so near to argillaceous, or roofslate, that it is employed for common gravestones. In Halifax, Vt., there is a quarry of this character; and, I believe, also in Chesterfield, Mass. Sometimes it forms excellent whetstones; and from the quarries in Enfield and Norwich, large quantities are obtained and extensively used.

Talcose Slate.

The principle value of this rock, in an economical point of view, is derived from its power of resisting high degrees of heat. The greater the proportion of talc in its composition, the more valuable is it in this respect. A very fine stone of this description, for the lining of furnaces, is quarried in Stafford, Ct., and it is employed to some extent in the furnaces in Massachusetts. I do not know of any quarry of this kind in our own state; but undoubtedly such might be opened; since almost every variety of talcose slate exists here. Indeed, I am informed by the Rev. Mr. Colton, of Amherst Academy, that talcose slate, equal to that in Stafford, may be dug in Monson.

In Plainfield and Hawley a variety of talcose slate occurs, in which are disseminated numerous crystals of black hornblende. The talc is green and the quartz white, and the rock admits of a polish. Sometime the talc almost disappears; and then we have a white base with black crystals imbedded. In short, I feel satisfied that this rock would form a beautiful ornamental stone, if wrought into tables, urns, chimney pieces, &c. &c. But of this others can judge from the specimens which I shall place in the collection already referred to. Large blocks of it may be obtained, which would be very firm throughout.

Limestone.

Next to our granite and gneiss, this is the most valuable rock in the State. Little advantage is derived from it, however, by any part of the State except Berkshire. Small beds of it do, indeed, exist in the eastern part of the State; but they rarely furnish blocks sufficiently large and sound, to be wrought into marble. And on account of the high price of wood in the vicinity of Boston, it cannot be burnt into quick lime, so as to be afforded at a less price than the lime brought from Maine. In many places, however, it continues still to be burnt. Judging from the appearance of the quarries, I should suppose that Bolton furnishes a greater quantity of lime at present, than any other locality. The stone here is mostly crystalline, and white, although it is apt to be much mixed, as it is at every other locality in the eastern part of the State, with a variety of minerals, that much injure it for lime. Beds of this limestone occur at Newbury, Bolton, Boxborough, Acton, Littleton, Carlisle, Chelmsford, and Stoneham. That in Stoneham is peculiarly fine; and could large blocks of it be obtained, free from fissures and foreign minerals, it would undoubtedly answer well for statuary. When there shall be a greater demand for a stone of this description, perhaps a farther exploration will bring to light, at this quarry, many larger and sounder pieces.

On the south of Boston, at Walpole, is a bed of limestone of a gray color and probably somewhat impure. It would, however, make good lime; and, indeed, it was burnt in considerable quantity some years ago. But until the lime from Maine and Rhode Island, shall sell at a higher price, this cannot be profitably prepared. It must be gratifying, however, to the inhabitants of the eastern section of the State, to know that such abundant sources of this valuable rock are within their reach, should their present means of supply be cut off.

The limestone quarries in Smithfield, Rhode Island, are so situated as to be of great importance to Massachusetts, being accessible to a large portion of the southeastern part of our State, and lying close to the Blackstone canal. The limestone here is white and granular; very much resembling that in the towns northwest of Boston,—especially that in Stoneham. It occurs in two principal beds, about two miles apart. I was told by an agent of one of the companies, which own this limestone, that not far from twenty thousand casks of lime, containing from thirty eight to forty gallons each, and worth nearly two dollars each, were annually prepared in the whole town.

Several beds of limestone may be seen on the Map in the eastern part of the range of mica slate in Franklin county, west side of the Connecticut, in the towns of Whately, Conway, Ashfield, Colerain, &c. But this limestone is quite impure, and is not generally distinguished, by the inhabitants of those towns, from the mica slate. It becomes an interesting inquiry, to those residing in the valley of the Connecticut, where quick lime is more expensive than in any other part of the State, whether this stone can be profitably converted into mortar. Very few attempts have yet been made to burn it, and those obviously quite unsatisfactory. Those who made these attempts probably thought that the stone, after burning, would slack with as much energy and readiness as pure quick lime; and because the process went on slowly and feebly, they have inferred that the lime would be of no value. At least, I know this to have been the conclusion in one instance, in which I had procured the burning of a considerable quantity of this limestone, in a regular lime kiln. But the mason, not seeing it slack briskly, did not think it necessary to apprise me of what he was doing, and mixed it with other lime, and defeated the whole experiment. I have, however, burnt a few pounds of this stone in a common chemical furnace, and found it to form a very excellent mortar; although requiring less sand than pure lime. Bricks cemented with it two or three years since, still remain as firmly united as ever.

This limestone contains a large proportion of silex, which, on burning, becomes a harsh sand. Wishing to know how much of pure carbonate of lime was contained in it, I powdered and dissolved portions of it, from different localities, in muriatic acid; and the results were as follows:

1. Purest variety from Whately; 100 parts contain carbonate of lime 78; residuum (chiefly sand) 22 parts

2. Compact variety from Conway; carbonate of lime 58 parts; siliceous residuum 42 parts.

3. Poorest from Whately; carbonate of lime 67 parts: siliceous residuum 33.

I tried some specimens of our best limestones in the same manner, with the following results:

1. Gray limestone from New Marlborough; carbonate of lime, 98 parts: residuum (chiefly mica) 2 parts.

2. Gray limestone from Walpole; carbonate of lime 92 parts: residuum 8.

3. White crystalline, from Boxborough; carbonate of lime, 99 parts: residuum 1 part.

It is my decided opinion that the limestone along the Connecticut, described above, may be usefully employed either for mortar, or for spreading upon the soil. The beds of it are quite numerous in all the towns where they are occasionally marked. I think, however, that the best variety occurs in Whately, where, should it ever come into use, on the north line of the town, is a hill large enough to supply the whole valley of the Connecticut for centuries. This locality is favorably situated for working, so as to furnish that valley; being not more than two or three miles from the Connecticut, and the whole distance nearly level. I cannot but hope that the attention of some enterprising gentleman may be directed to this subject; and should he succeed in preparing even tolerable lime from this rock, he would confer a great favor upon the inhabitants of that section of the State.

A large portion of the limestone in Berkshire is excellent for burning into quick lime: and even in several towns where none of the rock occurs in ledges, so abundant are the loose masses, transported thither by a current of water in early times, that it is burnt in considerable quantities. This is the case in Windsor, Peru, &c., from whence lime is transported in wagons to the valley of the Connecticut.

Probably, however, a still larger proportion of the lime used in that valley, particularly in its northern part, is brought from Whitingham, Vt., a town lying directly north of Rowe in Franklin county. This limestone is white and crystalline, and it exists in large quantities. It approaches within a few rods of the Massachusetts line, and may even pass over it in some places.

An interesting bed of limestone of a peculiar character, has been discovered, within a few years, in the valley of the Connecticut at

West Springfield, a few miles south of Mount Tom. It is the bituminous limestone, and is quite impure. But it answers well, and that too on account of its impurity, for water proof. cement, or mortar that will harden under water. It was used on the Farmington canal, particularly in the construction of the aqueduct across Westfield river. The same rock occurs at Southington and Middletown, Ct., and I doubt not may be found in many other places, along the river, associated with the new red sand stone. I am not aware that the bituminous limestone has ever before been used as a water proof cement. In Europe, and I believe in New York, the blue argillaceous limestone is employed. Pure lime, however, will answer the purpose, if it be mixed with puzzolana or tarras. The former of these substances is decomposing lava, and the latter decomposing Basalt. I doubt not but that decomposing greenstone will answer as well; and if so, it can be found in abundance on the north of Boston, and along the Connecticut river. Lava, basalt, and greenstone, are so much alike, that I think the latter well worth a trial. Indeed, if I recollect aright, the experiment has already been successfully tried in New Haven, Ct.

As the Springfield limestone is abundant, it would be very desirable to have it tried upon some land in the vicinity: for, if it answers well in agriculture, (and I see no reason why it may not,) it might prove an invaluable acquisition to the farming interest of the Connecticut valley.

Postscript.—Discovery of good Limestone in the Valley of the Connecticut.

After the preceding remarks upon the limestones of Massachusetts were written, I received specimens, through the kindness of Mr. Henry W. Cushman, of crystalline carbonate of lime, found in Bernardston, near the center of the town, and a short distance from the stage road from Greenfield to Brattleborough, Vt. I immediately visited the spot, and found, indeed, a large bed of limestone, in the argillaceous slate, not less than fifty rods long, and three or four rods thick, appearing at the summit of a hill, and dipping nearly south east at a small angle. In the limestone is a large bed of iron ore, which was dug forty or fifty years since, and with the limestone sent to Winchester, N. H. to be smelted. Neither the limestone, nor the iron have been thought worthy of attention since. But a kiln of the former has recently been burnt, and found to produce a very strong lime, although of a rather darker color than the white limestones generally produce. This results from a quantity of the oxide of iron, which penetrates the seams of the rock : but this does not injure the stone for mortar, and probably even makes it more valuable. The bed is only three or four miles from the Connecticut, and on the bank of Fall River, a small stream that empties into the Connecticut. By going to Cheapside, in Deerfield, (eight miles,) over a level and excellent road, water communication with the whole valley of the Connecticut, will be reached. I have little doubt, that if this limestone should be extensively burnt, it will reduce the value of quick lime in that valley, from twenty five to fifty per cent. : a benefit superior to any that could be conferred by the discovery of a gold or silver mine.

I dissolved some of this lime, in diluted nitric acid, to see if it contained magnesia. The solution was not milky, and therefore no magnesia was present. I also dissolved 100 grains in muriatic acid, and the siliceous residuum was only a single grain : the 99 grains are probably chiefly carbonate of lime; although whatever amount of oxide of iron was present, would also be dissolved.

Marble.

The limestone of Berkshire is best known for the fine marble which it produces. It is all of that variety denominated primitive marble. It is always more or less crystalline, sometimes very coarsely so. The prevailing color is white ; and this is the variety most extensively wrought. Some varieties are snow white, and admit of a very fine polish. From this pure white, the color changes by imperceptible gradations to gray, and dove color. These varieties form delicate marbles. But probably most persons would say that the clouded variety, where the white and the gray are fantastically mixed, is most elegant.

More or less marble is quarried in almost every town of Berkshire county, except a few on its eastern side. But the towns where it is most extensively wrought are West Stockbridge, Lanesborough, New Ashford, Sheffield, New Marlborough and Adams. A few years since, Prof. Dewey stated the amount of marble annually furnished by West Stockbridge, to be sixteen thousand square feet, valued at \$25,000 to \$30,000 : the amount at Lanesborough, seven thousand feet; value \$10,000 : and in Sheffield, to the value of \$8,000. In all the county, the annual value of marble was estimated to be more than \$40,000. Still more recently there were in operation in West Stockbridge for sawing marble, nine mills, moved by water power ; and two hundred hands were employed. From twelve to fifteen quarries had been opened, and in 1827, about two thousand seven hundred tons of marble were exported from this town. The marble used in building the city hall in New York city was chiefly from this town. A part of the marble in the state house in Boston, was from the same place. In 1828, a charge of two hundred and four pounds of powder, was put into the rock in one of the West Stockbridge quarries, and a block from fifty to sixty feet square and eight feet thick, was raised; and as much more loosened.

The Lanesborough marble is of a superior quality, and a good sample of it may be seen in the capitol at Albany. The New Ashford quarries furnish a marble of the same kind; and several quarries are opened. Only one mill is there erected for sawing it into slabs. A mill of the same kind is in operation in Lenox, and another at New Marlborough. In Sheffield, three quarries are opened. In Alford, two. In Egremont, a bed of marble limestone extends nearly through the town.

There can be no doubt that greater facilities for the transportation of the Berkshire marble—such as a rail road to the Hudson—would greatly increase the demand for it, by reducing its price. Such facilities will undoubtedly be provided at some future time. For as a country grows older, and increases in wealth and refinement, its valuable and ornamental minerals and rocks will be more sought after and used. The inhabitants of Berkshire cannot, therefore, but regard their inexhaustible deposits of marble and common limestone, as a rich treasure to themselves, and an invaluable legacy to their posterity.

The limestone of Smithfield, R. I. and of Stoneham in this state, bears a close resemblance to that which produces the celebrated Carara marble of Italy. But as yet, few blocks have been obtained at either of these localities, large enough and free enough from fissures, to be used for statuary.

Serpentine.

In richness and variety of colors, this rock exceeds all others; and is, therefore, eminently suited for ornamental sculpture and architecture. The prevailing color is green, of different shades, spotted or clouded, or veined with other colors; and hence its name, from its spotted and striped appearance, bearing a resemblance to the skins of some serpents. In hardness, it varies very much; being in some instances very hard, and in others as easily wrought as marble.

This rock exists in Massachusetts in great abundance, particularly in the Alpine part of the state, or in the Hoosac mountain range.

The most extensive bed occurs in Middlefield, in the southern part of the town. This bed cannot be less than a quarter of a mile in breadth and two miles long. The colors of the rock are various, and its hardness unequal. If wrought, it might supply the whole world. It yields both the precious and common varieties. There is another bed in the same town, associated with steatite or soapstone. In the west part of Westfield is found another extensive bed of this rock, extending into Russell, of a much darker color, and containing green talc. This has been used in a few instances for ornamental architecture, and has a rich appearance when wrought. Two beds of a similar serpentine are found in Blanford, and another in Pelham, in the south west part of the town. The color of this last is quite dark, and the quantity of the talc is considerably large. A large bed occurs in connection with soapstone, on the north side of Deerfield river, in Zoar, near the turnpike from Greenfield to Williamstown. Specimens from this place resemble those from the celebrated localities of this rock at Zoblitz, in Saxony. Serpentine also exists at Windsor in two beds; and there is an immense bed of it in Marlborough, in the lower part of Vermont, as also in several other towns in that vicinity.

The only locality of this rock in the eastern part of the state, that I know of, is in Newbury, two and a half miles south of Newburyport, near the Boston turnpike, at an abandoned lime quarry. The precious, or noble serpentine is found here very beautiful, and very much resembling that of Cornwall, in England. No serpentine in the state will compare in beauty with this; but perhaps if the other beds were explored by blasting, they would put on a different aspect. Serpentine also exists at Newport, R. I., but I have not seen it in the bed.

Serpentine and limestone, irregularly mixed, form the noted *Verd Antique* marble. Such a mixture occurs at Becket, according to Prof. Dewey, in a bed of gneiss. The limestone is also sometimes mingled with the serpentine at Newbury and at Westfield. I cannot see why these varieties are not Verd Antique, though I would not decide very confidently. At New Haven and Milford, Ct. extensive quarries of Verd Antique marble have been opened.

Considering the extent and variety of serpentine in Massachusetts, it seems not a little surprising that no efforts, or next to none, have been made to use it for ornamental or architectural purposes. In Europe, it is employed for trinkets, vases, boxes, chimney pieces, and even columns of large size. In Spain, it is said that churches and palaces abound with columns of this description. If ever the serpentine of Massachusetts shall be extensively wrought, I doubt not that specimens will be obtained, rivalling the finest varieties of Europe. It is not at present easy to obtain hand specimens, that shall give a fair representation of this rock, because it is injured to a considerable depth, from the surface exposure.

Steatite or Soapstone.

This is the softest of all the rocks employed in architecture. This property, rendering it easy to be sawed or cut without injuring an edge tool, and its greasy or soapy feel, are such striking characteristics of this rock, that most people are acquainted with it. It is sometimes called *potstone*, and sometimes, in this country, *freestone.*

Next to the ease with which it may be wrought, its great power in resisting heat, is the most valuable property of this rock. Hence it is extensively employed for fire places and furnaces.

It is also turned into crucibles and small furnaces for culinary use. Inkstands are made of it in great numbers, and various other articles. As it hardens in the fire, it is used in Europe for imitating engraved gems. It has been employed in various countries as a substitute for soap and fuller's earth. Spanish and French chalk are varieties of steatite. Savage nations are said to mitigate hunger by eating this soft mineral; as however it contains nothing alimentary, it can act only as a palliative of hunger.* Those varieties that are most infusible, are employed in England extensively in the manufacture of porcelain.

Steatite, like serpentine, usually occurs in beds of no great extent. They are numerous in Massachusetts, and very commonly they are associated with serpentine, or in the vicinity of it. This is the case in the northwest part of Middlefield, where one of the finest beds of it, in our State, is found; although it contains small masses of *bitter spar*, which renders it less easy to work. But this quarry has been explored more extensively than any other in the state; and the blocks transported to Northampton, and even to Boston. In Windsor are not less than three beds of this rock, from which the New Lebanon shakers obtain it, for converting into inkstands. I was told that a bed of it exists, in Cheshire. Another occurs in Savoy; one in Hins-

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* See Brongniart's Mineralogy.

dale; one also in Blanford, which is wrought and produces an excellent stone. Two beds occur in Granville, which I have not visited. Another is opened in Zoar, where are two distinct varieties, one nearly white, another of a deep green. In Rowe is another quarry, where these two varieties are equally distinct. At the two last named localities, however, the rock is distinctly green and white talc; and indeed, the two minerals (talc and steatite) are probably in every case identical.

On the east side of the Connecticut river are several beds of this rock, more or less quarried in every instance; but in general not explored deep enough to develop the rock in its unaltered character: for the air and moisture generally affect it for several feet deep. In the south part of Shutesbury is one bed: in the southwest part of Wendell another: and two miles east of the centre of New Salem, a third. The quality of the rock at these places, is not as good as that west of the river; though it has scarcely been explored at all, at the localities above mentioned.

In Groton is a bed of soapstone on which considerable labor has been expended. Its width appears to be 10 or 12 feet, and it descends into the earth towards the southeast; dipping about 30°, and lying between layers of mica slate. It is not of the best quality, being somewhat too hard: yet its proximity to Boston, Newburyport, and Salem, will probably render it an object of importance.

In the states adjoining Massachusetts, and not many miles from its limits, several extensive and valuable quarries of soapstone have been opened. In Vermont, they occur at Marlborough, Windham, and Grafton. In New Hampshire, very fine steatite is found at Francestown. In Connecticut, a bed is wrought in Somers. The Grafton steatite is employed extensively and successfully for aqueducts: the joints being connected by sheet lead. A bed of this rock exists in Smithfield, R. I.; although it is not wrought; there are beds also in several other places in that state.

From the preceding statements it seems, that in this state, and contiguous to it, immense quantities, and every variety of steatite exists. As yet, however, the working of it has hardly commenced; although almost every man is aware of the value of this rock; and there are few who do not sometimes stand in the need of it for economical purposes. As the facilities for transportation are multiplied, and particularly in the mountainous part of the state, its use will undoubtedly be greatly extended. At present I believe, the shops in Boston are supplied from Vermont and New Hampshire.

Graywacke.

For the most part, this rock furnishes a coarse stone only fitted for a common wall; but sometimes its stratification is so regular, and its grains are so fine, that it answers well for underpinning, step stones, &c. It is quarried I believe in Brighton, and some other towns in the vicinity of Boston. At Pawtucket, on the R. I. side of the river, is an extensive quarry of a fine grained and slaty variety, which I should judge would form a good flagging stone; and immense quantities have been taken away for this object and for other purposes. On Canonicut island in that state, is also a valuable quarry of this rock.

Graywacke is sometimes beautifully amygdaloidal: that is, it contains numerous rounded or almond shaped nodules of some other mineral. In these instance, however, the base of the rock is rather *Wacke*, than graywacke. This wacke (which resembles indurated clay,) often forms the cement of graywacke. In Brighton it is of a reddish color, while the imbedded nodules are sometimes white, and sometimes white feldspar with epidote, which is of a lively green color; and these substances are not only in rounded masses, but in veins of irregular shape. The rock is hard and may be even polished. It then resembles porphyry and is very elegant. A fine example of this may be seen at the residence of H. A. S. Dearborn, Esq. in Roxbury, forming a pedestal for the bust of his father. It is only slightly polished, but would generally be mistaken for porphyry. A similar amygdaloid occurs in Brookline, Newton, and Needham. A variety still more beautiful is found at Hingham. The color of the base is chocolate red; and the nodules are red, green and white. I do not know whether large blocks can be got out.

I think upon the whole, however, that the finest amygdaloid occurs in Saugus, on the hill a few rods east of the meeting house. The base is a pleasant green, and the nodules white, compact feldspar, generally spherical, and thickly interspersed. If polished, it must be exceedingly fine; and I have little doubt that large blocks can be obtained at this locality.

Argillaceous Slate.

A more common name for this rock, at least for the most useful variety of it, is *roofslate:* because it is used for forming the roofs of houses. I have been inclined sometimes to regard the ranges in Quincy, Watertown, Charlestown, and Chelsea, as a fined grained variety of graywacke; but this question may be more properly considered in the scientific part of my report. At any rate, this rock, in the towns above mentioned, does not split into layers sufficiently thin for roofing. But it is valuable for grave-stones, the covering of drains, flagging stones, &c ; and for these purposes it is extensively wrought in Quincy, Charlestown, &c.

Novaculite.

This is a variety of argillaceous slate which is known in the arts under the name of hone, oil stone, turkey stone, and whet stone. It is in beds of argillaceous slate in Charlestown, Malden, and Quincy. It is not however of a very good quality; and I am not aware of its being used for hones, or even for whet stones; although it might answer the purpose, if better materials could not be found elsewhere.

Roof Slate in Worcester County.

The range of slate exhibited on the Map in the towns of Boylston, Lancaster, Harvard, Shirley and Pepperell, is associated with the peculiar mica-slate that contains the Worcester coal. It answers for roofing in some parts of the bed and has been quarried for this purpose in Lancaster. It has been wrought considerably in Harvard and Pepperell for grave stones; and is transported a considerable distance for this purpose. The stratum is narrower near the north line of the state: but I have found no time to ascertain how far it extends into New Hampshire.

Connecticut River Slate.

Although a large part of Bernardston is represented as composed of this slate, yet its characters are not perfectly developed, till we pass into Vermont. In Guilford, Brattleborough, Dummerston, and even 50 or 60 miles northward, it produces an excellent material for roofs, writing slates, &c.; and extensive quarries are opened in it in those towns. The best slate used in Massachusetts probably comes from this range. In Bernardston it is quarried to some extent for grave stones.

Berkshire Slate.

The mica slate of the western section of the State, passes gradually into roof slate, and in most instances the characters of the latter are not very perfectly exhibited, until we have entered New York. There, however, in Hoosac, and other towns, it is quarried extensively for roofing: and the western part of Massachusetts is always sure of a supply of this valuable material from that quarter; if not within its own limits.

Graphic Slate.

This occurs in small quantities, along with the argillaceous slate, in Lanesborough and Williamstown; also abundantly in Bennington, (Vt.) Prof. Dewey, from whose account I derive this fact, does not state whether it is pure enough to be employed by artificers for drawing lines, and for crayons; uses to which this mineral has been applied in other countries.

New Red Sandstone.

This rock occurs in Massachusetts, only in the vicinity of Connecticut river; along which, on both sides, ranges extend from Middletown, (Ct.) to Vermont. It affords large quantities of good stone for building and other purposes. Some of the numerous varieties of this rock are slaty; and either of a red, gray, or black color. These varieties furnish good flagging stones; and the side walks of all the principal places along the river, are chiefly covered by them. In the more common varieties, the strata are from six inches to two feet or more in thickness; and for the most part, the color is red, though sometimes gray. From hence is obtained most of the rock of this formation used in architecture. The most delicate variety occurs in Long Meadow and Wilbraham. It consists simply of an almost blood red sand, cemented probably by iron. It is remarkably uniform in its color and composition; and forms a beautiful and most valuable building stone; though liable to be easily injured and sometimes disintegrating by exposure. The quantity of this rock is inexhaustible, and it occurs only from three to five miles from Connecticut river; the intervening region being nearly level. A great number of quarries are now explored; but I have no means of determining how great is the demand for the stone. The celebrated Chatham quarries, on the banks of Connecticut river, in Connecticut, are opened in the same kind of rock, although of a coarser variety.

Another variety of the new red sandstone, quarried in many places in Massachusetts and Connecticut, is coarser than the Long Meadow stone; but being harder, it is more enduring, though less elegant. A gray and rather coarse variety is used in some places, e. g. in Granby, (Mass.) This, indeed, with the other varieties mentioned above, forms excellent underpinning, door and window caps, and foundations, and door steps; and, like the Berkshire marble, they are sometimes wrought into sinks and other similar articles. The ease with which the rocks of this formation are wrought, forms a great recommendation: and were they as enduring as gneiss and granite, these latter rocks would soon be neglected.

Tertiary Formations.

I suspect there are only two varieties of these formations in Massachusetts: one developed most perfectly in the west part of Martha's Vineyard, and the other, and the most extensive, along the Connecticut river, although common in limited patches all over the State. Neither of these formations furnishes stones sufficiently firm for architectural purposes, although in a few instances, I have observed limited beds of the clay, sand and pebbles, that compose these formations, to be in a state of consolidation. Nearly all our clays, however, are in the tertiary formations, and these are so important in an economical point of view, as to demand a particular description.

Porcelain Clay.

This is the purest of all the clays, and is the only one employed in the manufacture of porcelain, or China ware. It results from the decomposition of granite; and hence we might expect to find it in Massachusetts; since we abound so much in granite. As, however, the manufacture of this ware has but recently been introduced into this country, little effort has been made to discover this clay. It has been announced, as existing in several towns in the State, although the bed in Savoy, described by Prof. Dewey, in his account of the geology of Berkshire, is probably the only one known that merits a notice in this report. It is said to constitute a layer three feet thick, and of unknown extent, several feet below the surface. It contains coarse particles of quartz, which can, however, be separated by sifting. It resembles the porcelain clay of Monkton, (Vt.) which is regarded as of a good quality. It forms a very cohesive white paste, and crucibles made from it, and burned in a common fire, were sonorous when struck. A similar clay is said to occur in large quantity, in Canaan, (Ct.) According to Dr. Porter, it is found likewise somewhat abundantly in Plainfield.

A part of the extensive clay beds on Martha's Vineyard, appears to be porcelain clay; especially in Chilmark: though a large proportion of mica is mixed with it.

Potter's Clay.

This is the clay so extensively employed for common pottery, pipes, tiles, and bricks. And fortunately it is found on almost every square mile in the State. We have two quite distinct varieties. The purest, sometimes called pipe clay, is found almost exclusively on Martha's Vineyard. This is white, and contains usually so little iron, that when burnt, it becomes still whiter, and will resist a high degree of heat. Hence it is employed for making what are called fire bricks, which are used for lining furnaces. White pottery is also made from it. But the more common clay turns red on burning, in consequence of the oxide of iron in it; and this renders it much easier to be melted by the heat, and consequently diminishes its value. It is of immense value, however, to the State; because good bricks may be made from it; and because it exists so abundantly in almost every town. The same tertiary formation that supplies clay so plentifully, yields an abundance of sand for the mortar by which they must be cemented. This sand, however, is generally rather fine; and I am inclined to believe, from all that I can learn, that our mortar is generally prepared from sand that is too fine.

Substitute for Fuller's Earth.

The common clay along the Connecticut river, has recently been employed in Northampton, in the place of fuller's earth, in cleansing cloth. A considerable quantity of it has also been sent down the river, for use in other places. This clay is fine grained, and when dry, adheres strongly to the tongue. It is said to answer exceedingly well in the place of fuller's earth; on this point however, I have my information at second hand. A clay of precisely the same character has recently been put into my hands from Leominster, where it occurs in alternating layers with sand. Some of the sand of this tertiary formation, especially in the gneiss region, is of a delicate white color, and quite pure. In some cases, when its finest particles are mixed with clay, it will answer very well for giving a polish to brass and other metals.

Clay used in the manufacture of Alum.

The white clay of Martha's Vineyard, is employed extensively in the manufacture of alum, in Salem; by the process of Chaptal, I suppose; although the details are, I believe, kept secret. By his method, sulphur and nitre are burnt in a chamber with the clay, which, after a considerable time, is lixiviated, and the ley evaporated. There is indeed, a variety of Clay which contains sulphur, that will produce alum without the addition of other materials; but I cannot believe that from the Vineyard to be of this description. At any rate the alum which the Salem company produce, is of a good quality, and is made in large quantities. They formerly obtained their clay from Gay Head; but they now procure it of a better quality from the west side of the island, in Chilmark.

Clay as a Manure.

Writers on agriculture, speak of clay as next in value to marl, for manuring light and sandy lands; and I cannot but think that our farmers have yet something to learn on this subject. Marl, they cannot procure, but at a great expense; but clay is usually at hand—and we have very much of the land which it will help. Yet I am not aware that in any instance the experiment has been thoroughly made.

Marl.

Marl for our farmers, scarcely exists in the State, except in a few places in Berkshire county, where it is of little use, because the soil already contains so much calcareous matter. It is said to have been found in Lancaster, but whether in large or small quantities, is not stated. Judging from the nature of the surrounding country, I venture to predict that it will not be found there in abundance. In Duxbury also, it occurs in considerable quantity. In Pittsfield, is a bed of earthy marl, but not extensive. It is found more abundantly, it is said, in Lenox; and it exists also in Williamstown.

Peat.

This useful substance must be regarded as alluvial in its character, since the process of its formation is now going on. It results chiefly from mosses and other plants, more or less decayed. In the eastern part of the State, it is found in great quantities. West of Worcester, it has scarcely been sought after, on account of the comparative abundance of wood. It will probably, however, never be found so abundantly in the western part of the State, as in the eastern. I have ascertained the existence of peat in the following towns, and do not doubt that it occurs in many others. There are two varieties; the fibrous and the compact. In the former, the moss, turf, and roots out of which peat is formed, have not lost their fibrous structure: but in the latter, they are converted into a compact and nearly homogeneous mass.

The fibrous and compact varieties, probably exist at nearly every locality. I am sure of their occurrence in Cambridge, Newton, and

Lexington; and in large quantities. Peat is abundant in Seekonk, Uxbridge, Cohasset, Duxbury, Hingham, Medfield, Walpole, Wrentham, Dover, Framingham, Sudbury, Topsfield, Ipswich, and Nantucket.

It exists and has been dug in greater or less quantities in Pittsfield, Leverett, Shrewsbury, Lancaster, Southborough, Hopkinton, Medway, Halifax, Stoughton, Boylston, Reading, Milton, Needham, Concord, Billerica, Bedford, Waltham, Watertown, Acton, Wilmington, Danvers, Chelmsford, Hamilton, and in nearly all the towns in Barnstable county; certainly in Yarmouth, Brewster, Orleans, Eastham, Wellfleet, and Truro. I have marked on the Map, only the most important localities.

The value of peat for fuel, is generally known; but I apprehend that it is not generally known that a still more important use may be made of it in agriculture. Peat swamps in Massachusetts are commonly surrounded by light and poor land. While the swamp itself contains too much vegetable matter, imperfectly decomposed, the land around it contains too little. All that is needed, therefore, is to employ the excess of the one, to supply the deficiency of the other. Hence, as an English writer remarks, "peat or vegetable matter, should be carried from the peat moss to the poor soil, and the surface mould from the poor soil to the peat moss." The peat ought indeed to be converted into manure, by lying awhile in a barn yard, or by mixing lime, or other substance with it; and there are particular directions to be observed as to the whole process, which this is not the proper place to explain. But they can be learned in works on agriculture; and whoever undertakes thus to make use of peat, without learning the results of enlightened experience on the subject, will probably fail in his object. But since great benefit has been derived from the use of peat as a manure, in England and Ireland, no reason can be assigned why it may not thus be applied in this country with equal success.

I cannot but regard the existence of so large quantities of peat, on Cape Cod and Nantucket, as a great blessing to the inhabitants. Yet from the little of it, which I observed to be dug there, I am apprehensive they do not realize its value. Most of the soil in those counties is precisely of that kind, which needs the admixture of much vegetable matter. If the peat swamps could be drained, and after the removal of a portion of the peat, be covered with lighter and warmer soil, but few years would elapse before they would become fine grass plats; while the sandy and more elevated land, enriched by the peat, would produce large crops of Indian corn, rye, and other vegetables. That this is not mere hypothesis, has been demonstrated on a small scale, at least, upon one farm, that of the Hon. John Reed, of Yarmouth. Since the inhabitants of Cape Cod are beginning to turn their attention more and more to the cultivation of the soil, may we not expect that such a transformation will ere long be common.

A few other mineral substances, interesting in an economical point of view, may perhaps be appropriately noticed in this place.

1. *Granular Quartz and Sand for the Manufacture of Glass.*

From some unknown cause, the granular quartz in Cheshire, Berkshire County, is so much disintegrated, that it easily crumbles into a beautiful white sand. This forms a good material for glass, and has been employed for this purpose a number of years; formerly in Cheshire and Warwick, Mass., and in Utica, N. Y.; and at present in Keene, N. H. It answers well for crown and cylinder glass. The quantity is inexhaustible. It is sold at the road, one mile from the bed, at $6\frac{1}{4}$ cents per bushel. This sand is employed extensively in Berkshire in the process of sawing marble.

I am inclined to believe that some of the sand associated with the tertiary and diluvial formations in the state, particularly in the gneiss region, is pure enough to be employed in the manufacture of coarse kinds of glass: such for instance as is found in Pelham and Leominster. The purest and coarsest variety, however, that I have met with, forms the shores of Lock's Pond, in the N. West part of Shutesbury. Similar sand, I believe is used for glass making in the eastern part of Connecticut.

When examining the milk white quartz, that exists in mountain masses in the east part of Cumberland, R. I: the enquiry forced itself upon my attention, whether it might not be employed in the manufacture of glass? Those particularly acquainted with that manufacture, can, however, judge better of this matter than myself.

2. *Buhrstone.*

In the same hill that furnishes the fine stratified quartz rock for architectural purposes, in Washington, three miles from Pittsfield, a porous quartz is found, which greatly resembles, and is used instead of buhrstone, for millstones. Whether geologists would allow it to be real buhrstone, may admit of doubt; since it is unquestionably a rock of primitive formation; whereas the real Paris buhrstone, is a member of the tertiary formation. But in an economical point of view, this question is of little importance, since the rock seems to answer nearly all the purposes of buhrstone so well that it is employed somewhat extensively for millstones. These are manufactured near the ledge, and sold for seventy or eighty dollars each. I am told that they answer well, especially for the coarser kinds of grain. I should presume that the only difficulty would lie in their being less tough than the genuine buhrstone. The quantity at the ledge is inexhaustible.

Sometimes our citizens employ the finer and more compact varieties of granite for millstones. I have seen even a coarse *conglomerate*, or *puddingstone*, used for this purpose. And while upon this subject, I cannot but express my surprise that no attempt has been made to employ our greenstone, and other hornblend rocks, for millstones. In Great Britain, basalt has been, within a few years, used for this purpose, and found even superior to the French buhrstone; and our greenstone is only a variety of the same rock: indeed, some of our greenstone cannot be distinguished, by the eye, from the European basalt. It is generally extremely compact and tough; and although its preparation might require a little more labor than the buhrstone, yet it would doubtless last enough longer, amply to pay for the additional labor. In the vicinity of Boston and along the Connecticut river, as may be seen on the Map, greenstone exists in great quantities. It also occurs in small beds throughout the whole extent of the gneiss region; and of a kind, which I should suppose from its appearance, would answer the purpose even better than that of the extensive ranges above mentioned.

Coal.

Of this mineral, the object of so much interest in every civilized country, there are found three distinct species; all of which are sometimes employed as fuel. The most common in Europe, which is there considered the best, is the bituminous coal, or that containing bitumen. This burns readily with a yellow or white flame. A second species is the anthracite, or *stone coal;* which is generally described as burning without flame, because destitute of bitumen. The anthracites of this country, however, burn with the flame that results from the combustion of hydrogen; this gas existing in a state of combination, either with the carbon, or in the water which the anthracite contains; and it is liberated by the heat. The great difficulty in the use of anthracite, consists in igniting it: a difficulty which has almost disappeared before the ingenuity of our countrymen. In Europe, anthracite has been described as of little value: with the exception, perhaps, of Killkenny coal. But our anthracite is either of a quality superior to the European, or we have learned better methods of employing it. All the coal obtained from the inexhaustible beds of that mineral along the Susquehannah, Lehigh, and Schuylkill, in Pennsylvania, is anthracite; and wherever it is skillfully used, I believe it is decidedly preferred to the best bituminous coals of England, or the United States. The coal from Rhode Island, (chiefly from Portsmouth, at the north end of the island,) is also anthracite. The Worcester coal belongs to the same species: indeed, every enlightened man in this country now regards our anthracite as a great national blessing. But in Great Britain, their geological writers speak of the anthracites found in Ireland and on the European continent, as "carbonaceous matters, that can never be profitably worked, so as to become objects of statistical interest."—(Ure.) And Mr. Conybeare, in his admirable view of the English coal formations, speaks of the deposit of bituminous coal, as "the only one capable of being applied to purposes of extensive utility, which appears to exist in the whole geological series." Is not this an example of that hasty generalization, to which geologists are so prone?

A third sort of coal is commonly enumerated, called *lignite*, consisting of wood partially carbonized, and still retaining its form, more or less distinctly. All the kinds of coal, that have been mentioned, are found in Massachusetts; the lignite on Martha's Vineyard; the bituminous coal on the Connecticut river, particularly at South Hadley; and the anthracite at Worcester, and in small quantities, in the north part of Middleborough, in Bridgewater, and West Bridgewater, and near the line of the State in Cumberland, Rhode Island.* But do they occur in sufficient quantity and of such quality, as to render them of any statistical value?

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* Also in the sandstone at the Southampton level. Within a few weeks it has likewise been stated, that good coal, of some sort and in great abundance, exists in Braintree. Through the kindness of a scientific friend, residing in the vicinity, I learn that a company are about boring the rocks near the Rev. Mr. Perkins' Meeting House in search of coal; and he was told that in digging several wells, in the neighborhood, a substance was found resembling coal, which "burnt with a brilliant flame and a strong sulphurous smell," although he could not obtain a specimen.

The lignite exists only in small quantities in the clay of the Vineyard: and even if it formed extensive beds, it would not be of much importance; although it is used as fuel in some parts of Europe.

Genuine bituminous coal, in sufficient quantity to be worked to advantage, has never been found, except in connection with a particular series of rock, called the Coal Formation. Such a formation has long been supposed to exist along the Connecticut: extending across the whole of Massachusetts and Connecticut; and the strata have been bored in South Hadley, at least, in two instances, and once by a gentleman familiar with the real European coal formations. Several years ago, I myself delineated a coal formation, on a geological map of the Connecticut, published in the American Journal of Science. But further examination has brought me, unwillingly, to the conclusion, that no such formation exists along the Connecticut, and that the one which I then regarded as real coal measures, is in fact the new red sandstone, or its equivalent. In another part of this report, I shall give my reasons for this conclusion. But I would remark, that I do not feel so much confidence in this opinion, that I would urge the entire abandonment of all efforts to find coal: for the facts stated in respect to anthracite, will justify the opinion, that even if the rocks under consideration, are new red sandstone, bituminous coal may exist in it, in sufficient quantities to be worth exploring; although in Europe it occurs in such rocks only in thin seams. Certainly the coal found at South Hadley was of a superior quality.

If, as I suppose, the rock under consideration be the new red sandstone, there is another fact that ought to be recollected, viz. that this rock, in other parts of the world, is associated with rock salt, salt springs, and gypsum. No trace of rock salt has been found along the Connecticut; and as yet only a small quantity of gypsum has been discovered. Professor Silliman found a little of this mineral in the greenstone, associated with the sandstone in Deerfield, and Mr. Davis, Principal of the academy in Westfield, found the same in thin scales, between the layers of the shale, connected with the sandstone, on the banks of Westfield river in West Springfield. These facts, especially the latter, are sufficient encouragement for the research after gypsum. And when we recollect that on account of the softness of this mineral, it is liable to be deeply worn away at the surface, we should by no means despair of its existence in the valley of the Connecticut. I have compared a collection of specimens from the new red sandstone, that contains the gypsum of Nova

Scotia, with the rocks of the Connecticut valley, and they can hardly be distinguished from each other.

As to anthracite coal, it seems to occupy a wider range among the rocks, than genuine bituminous coal. Generally, however, the former occurs lower down in the rocks—that is in older rocks—than the latter. Sometimes it is found in what are called transition rocks; and sometimes in the primitive. In this country it is found in both these classes of rocks. We have in the United States, at least three extensive deposits of anthracite: the largest is in Pennsylvania; the next largest in Rhode Island; and the smallest in Worcester. I have examined them all, and have come to the conclusion, that all the rocks containing this coal, are at least, as low down in the series as the transition class: and I am rather of the opinion, that they all lie below the Independent coal formation of Europe; I mean on the scale of rocks. I suspect that the Pennsylvania anthracite occurs in the higher beds of the graywacke, perhaps even in the millstone grit, and the Rhode Island anthracite, in the lower beds of the graywacke. There is no geological connection between the Rhode Island and the Worcester coal, as Dr. Meade and others have supposed. By inspecting the Map, the two localities will be seen to be separated by granite and gneiss, from twenty to thirty miles across. The Worcester coal occurs in an imperfect kind of mica slate. It is what Humboldt calls transition mica slate: for a few miles north, it passes into distinct argillaceous slate. Following the range south from Worcester, it becomes more decidedly micaceous, and probably there forms a bed in gneiss. Indeed, in Dudley, I saw the same rock surrounded by gneiss, and highly impregnated with anthracite.

The bed of anthracite in Worcester, is about seven feet thick, and has a moderate dip to the northeast. It has been explored only a few feet, and the operations are now suspended. To continue them advantageously, it will be necessary to go down the hill, and remove the soil so as to find the lateral outcrop of the bed, in order to avoid an accumulation of water. This work has been already commenced.

The Rhode Island beds of this coal were opened several years ago, before the value of it was justly appreciated by the community. The sales not being brisk, the works were abandoned, and have never since been resumed; so that on account of the rubbish, I was unable to ascertain the width of the beds. I have always understood, however, that there was abundance of coal. The beds are less favorably situated for working, than that at Worcester.

The extensive, and rapidly increasing demand for the Pennsylvania coal, is a conclusive testimony to its first rate excellence. The experiments of Mr. Bull of Philadelphia, as well as those of Professor Silliman, recorded in the eleventh volume of the American Journal of Science, show that the best Rhode Island coal is not greatly inferior. The Worcester coal, burns with more difficulty: but gentlemen who have fairly tried it, and on whose testimony I can depend, assure me, that it may be employed successfully, and comfortably for fuel. There can be no doubt, that its quality is inferior to the coal of Pennsylvania, and also to that of Rhode Island.* But it may be very much inferior, and yet for many purposes, be exceedingly valuable. The fact is, anthracite has to struggle with prejudices wherever it is first introduced, arising chiefly from the comparative difficulty with which it is ignited; and it happens in regard to this substance, as with most things new and untried, that the community generally feel, as if their business was to find as many objections to it as possible; and the man who would bring any new substance into general use, needs no small share of patience, and perseverance. Dr. Meade states, that an experiment, made several years ago at Smithfield, upon the burning of limestone, with the Rhode Island coal, and another upon the burning of brick, in the vicinity of Boston, were thought to be complete failures, because the heat was so intense, that the surface of the lime and of the bricks was vitrified; whereas the fact ought to havet aught the experimenters, that a more careful regulation of the heat would ensure success. Indeed, I predict, that ere long, in nearly every case where a strong and steady heat is required, anthracite will be found superior to all other kinds of fuel; and that the anthracite of Rhode Island, and even that of Worcester, will be considered by posterity, if not by the present generation, as a treasure of great value. The Pennsylvania coal may indeed, for a great many years, command the market: but I apprehend, that the time will come, when the expense of its transportation to the Eastern States, and the increasing demand for it, will lead to the re-opening of the pits, that are now abandoned in New England.

In coming to the conclusion, that the anthracite of Worcester, and even that of Rhode Island, are inferior to the Pennsylvania anthra-

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* According to the experiments of Mr. Bull, a pound of the best Pennsylvania anthracite maintained ten degrees of heat in a room, 13 hours and 40 minutes; a pound of the Rhode Island coal maintained the same heat in the same room, 9 hours and 30 minutes; and a pound of the Worcester coal, kept up the same heat only 7 hours and 50 minutes. It is a curious fact that the specific gravity of the Worcester coal, is one third greater than that of the coal from the two former localities.

cite, geological considerations confirm the results of experiments. Baron Humboldt, who has probably seen more of the rocks of the globe, than any man living, remarks, that "anthracite is a more ancient formation than coal, and a more recent formation than graphite, or carburetted iron. *Carbon becomes more hydrogenated, in proportion as it approaches the secondary rocks.*" This last sentence, divested of its technical obscurity, means, if I understand it, that the newer the rock in which the carbon is found, the greater will be the quantity of hydrogen combined with it: and we know that an increase of hydrogen, will render coal more combustible. Now if I am correct in the opinion, that the Worcester anthracite is contained in older rocks than that in Rhode Island, and the anthracite of Pennsylvania, in rocks still newer than those of Rhode Island, we might expect, that the newer would prove the best for fuel, and the older the poorest, because containing the least hydrogen. The quantity of carbon, however, in the Worcester coal, is believed to be nearly as great, as in that from Rhode Island and Pennsylvania; although no analysis has been made of the former. But carbon is less combustible than hydrogen. Yet I can hardly believe, that a coal, which contains probably not less than 90 per centum of carbon, should not be employed, in some way or other, as valuable fuel.

The formation which I have denominated gray wacke, and which contains the anthracite in Rhode Island, extends northerly in interrupted patches, nearly across the whole of Massachusetts; as may be seen on the Map. The most southern patch, embraces nearly the whole of Bristol and part of Plymouth county: the second extends from Wrentham to Dedham: the third includes several towns in the vicinity of Boston; and the fourth is in Rowley and Newbury in Essex county. I know of no reason, why one part of this formation should contain anthracite rather than another: and hence we may reasonably look for it in any part of the graywacke formation, exhibited on the Map. The transition mica slate, containing the Worcester anthracite, occupies, as the Map will show, a large portion of the northeastern part of the state; and it would not be strange, if other beds of that mineral should be found in it.

Graphite, Plumbago, or Black Lead.

This substance has the color of lead, leaves a trace like that metal upon paper, and bears the common name, *black lead;* but it contains no lead. It is composed of above 90 per centum of carbon, and the rest is iron and earthy matter. Hence it differs but little from some varieties of anthracite. It seems indeed to be the form in which carbon occurs in the oldest of the rocks. In Massachusetts it exists in gneiss, at the most important locality, which is in Sturbridge. It there occurs in a bed, varying in width from an inch to about two feet, and traceable along the surface, nearly one hundred rods. A number of years ago this bed was opened; and several tons of the graphite obtained. It was then abandoned; but within a few years the exploration has been recommenced, and already more than a hundred tons have been obtained. In some places the excavation is six or seven feet deep. The quality of the graphite is excellent; and would not suffer by comparison, with almost any in the world. To what extent it may be obtained, it is not possible at present to determine. The fact, that the bed descends, almost perpendicularly, into the earth, is rather unfavorable to the miner. Yet, as it is found upon elevated ground, the mine can be conveniently drained by lateral cuts or adits to a considerable depth; and probably the exploration may be profitably continued for a long time with little machinery.

Graphite is employed for pencils, crucibles, lubricating machinery, &c. It occurs at several other localities in Massachusetts, besides that in Sturbridge, but not in large quantities, except perhaps in Hinsdale. It is said that a good bed of it has been opened in New Hampshire.

A substitute for Emery.

No real emery has yet been found in Massachusetts; but a rock composed of garnet and anthophyllite or augite, occurs in North Brookfield, which is employed as a substitute for that mineral, and it is said to answer well. The powder of the garnet, although much inferior in hardness to real emery, is indeed sometimes called in commerce, *red emery.* The rock in Brookfield is abundant, and may prove valuable.

Mineral Waters.

No mineral springs of much notoriety are found in the state, although chalybeate springs are very common, and are useful in cutaneous and some other complaints. Nearly all these springs rise in low ground containing bog ore. The Hopkinton spring is of this description, and is probably more resorted to than any other in the state. This contains, among other ingredients, carbonic acid and carbonate of lime and iron. The spring in Brookfield is similarly situated, and contains some magnesia and soda, as well as iron. It is a place of some resort. A mineral spring exists in Shutesbury, abounding in muriate of lime, and it is somewhat visited. Chalybeate springs exist in South Hadley, Deerfield, and indeed, in almost every town in the state. In Mendon I was shown a mineral well, in the waters of which, chemical tests indicate muriate of lime and carbonic acid in a free state. No use was made of the water, except as a substitute for yeast.

In Williamstown is a tepid spring very much resembling that in New Lebanon, N. Y. Bubbles of gas are constantly escaping, which, according to Prof. Dewey, are atmospheric air, and not simply nitrogen, which is common in such springs. This spring furnishes a convenient place for a bathing establishment; and though the saline ingredients are in small quantity, the water is useful in several cutaneous disorders. In Adams, Pittsfield, and Great Barrington, are springs useful for the same complaints. In Hinsdale is a spring from which issues sulphuretted hydrogen; and from the decomposition of this gas, a deposit of sulphur is made upon the earth around.

Other non-metallic Minerals; either useful or ornamental.

It may be well in this place, perhaps, to notice briefly a few other mineral substances in the state, such as are employed in Europe for useful or ornamental purposes. In this country the demand for them is yet comparatively small, and we have few artists devoted to their preparation; so that no demand exists for these minerals, as is the case also with our porphyries.

In Hatfield, is an immense quantity of the sulphate of barytes, of a superior quality. Within a few years, a patent has been taken out in England, for the use of this substance, as a paint, to be employed in those situations where lead paint is liable to be acted upon by moisture, acids and other chemical agents. In such cases, this barytic paint is excellent. I have been in the habit, for several years, of having various articles in the laboratory, such as the pneumatic cistern, gazometer, &c. covered with it; and it answers a good purpose, although I have prepared it, not according to the patent, but simply by grinding it in a plaster mill and mixing it with oil. The greatest defect in this paint, seems to be, that it has less body than lead, although I doubt not that a remedy may be found for this difficulty. When the barytes is thoroughly pulverized, and mixed with boiled linseed oil and lampblack, it is superior to any thing I have ever seen, for labeling glass bottles, &c. in a laboratory, and indeed for any situation exposed to active chemical agents.

The new alkali, lithia, is found chiefly in two minerals, called petalite and spodumene, which, in Europe, are very rare. But in Massachusetts they occur in very great quantities; particularly the latter. The former is found in Bolton and Westfield, and the latter in Goshen, Chesterfield, Norwich and Sterling. The lithia can now be obtained, by a chemical process, from the minerals of these localities, in any quantity; and should it prove to be a useful substance, as every alkali is likely to be, these minerals may become an object of importance.

Among the minerals in the State, that may be employed by the lapidaries, for ornamental purposes, may be mentioned chalcedony. Almost all its varieties occur in the greenstone ranges, in the valley of the Connecticut, and some of the agates which it forms are quite large, and need only polishing to be elegant. It occurs also in various other parts of the state, and in masses considerably large; but perhaps at none of the localities in such quantity, and of such quality, as to render it worthy the attention of the lapidary.

Agates, both banded and brecciated, are found in the State, made up of quartz, hornstone, chalcedony, &c. of various colors. The largest and most perfect specimen of quartzose agate breccia, which I have found, was shown me at Rochester Centre; and I was told it was broken from a much larger mass, in the same town.

In Saugus, near the center, is a fine locality of red jasper. It is not unfrequently striped, and if needed for ornaments, would undoubtedly admit a fine polish. The bed or vein has not been explored at all, except that a few fragments have been broken off by the passing mineralogist.

We have beryls, somewhat numerous, and sometimes very large; but probably they are not delicate enough, and are too much divided by seams, to be employed for elegant ornaments.

A garnet or cinnamon stone was found by Professor Webster in Carlisle, which, in its natural state, is a splendid gem. Good specimens, however, cannot now be obtained, without farther exploration of the soil or the rock.

The quartz crystals, that occur at several localities, are very perfect, and might be used for watch seals, ring stones, spectacles, &c.; those, for instance, found at Pelham, Southampton and Williamsburgh. The smoky quartz occurs at a few localities, and is fine for ornaments. At Southampton, Pelham and Middlefield, is found the yellow quartz, which, in some instances, can scarcely be distinguished from genuine topaz. The rose red quartz occurs at several places, as at Chelmsford, Chesterfield, Chester, Williamsburgh and Blanford; and sometimes, I am inclined to believe, of a good quality to be wrought into ornamental articles; particularly, at one or two localities recently discovered. The amethyst, which occurs in greenstone, along Connecticut river, is of a delicate color, and, if it can be obtained in sufficient quantity, may be employed in the ornamental arts.

Some of the adularia that is common in the gneiss of Brimfield, Southbridge, &c. I presume, would answer well for watch seals, rings and trinkets; particularly, a greenish variety, occurring near the center of the latter place. I have seen an elegant watch seal, cut from the adularia of this locality.

It ought not to be forgotten, that amber has been found in Martha's Vineyard, at Gay Head, and on Nantucket. At the latter place, one or two masses were found, weighing a pound or more. The tertiary formation of these islands is precisely the place where we might expect to find this mineral, especially in connexion with the lignite.

METALS AND THEIR ORES.

It remains only, in giving the economical geology of Massachusetts, to describe the metals and metallic ores which have been found in the state, and are applicable to useful purposes. I shall begin with the metal most abundant and most useful: viz.

Iron.

The bog iron ore is most common, but I shall give an account of the different species in regular order.

Mine of Arsenical Iron and Carbonate of Iron, in Worcester.

In the town of Worcester, in mica slate, is a bed of these ores, which was explored to some depth, a number of years ago, in search of the precious metals. A little galena or lead ore is found also, in the same mine. As the excavations are now nearly filled up, it is impossible to judge of the extent of this bed.

Arsenical iron is seldom explored for the purpose of getting malleable iron from it; although it is sometimes employed for the arsenic it contains, and for the preparation of sulphuret of arsenic. The carbonate of iron is an excellent ore; and has received the name of steel ore, because it may be readily converted into steel.

Mine of Carbonate of Iron and Zinc, in Sterling.

This is a bed, in mica slate, just like that at Worcester; and was extensively explored forty or fifty years ago, for the same purpose which led to the opening of that bed, viz. the discovery of gold and silver. The carbonate is the most abundant ore, and lies scattered about the excavation, in considerable quantities; although the sulphuret is common, which is sometimes arsenical. A reddish, foliated sulphuret of zinc also occurs here, in considerable quantity, and some sulphuret of lead. Whether this mine will be found worth exploring, it is difficult, in its present state, to determine. If it afford the carbonate of iron in large quantities, it will certainly repay the effort. It lies about a mile and a half south east of the center of the town.

Chromate of Iron.

It ought to be recollected, that a small rounded mass of this ore, so valuable in the preparation of the paint called *chrome yellow*, was found, a few years since, in Cummington, by Dr. Porter.

Phosphate of Iron.

The earthy variety of this ore has been found, in considerable quantity, at the mineral spring in Hopkinton. It forms a bed, one or two feet below the surface, and has been employed as a pigment. It is said to exist also near Plymouth.

Sulphuret of Iron or Iron Pyrites.

This is the yellow ore, so frequently mistaken for gold. It occurs more or less in almost every rock; but is of no use, unless it exists in large quantities, and is of that variety which easily decomposes. In such a case, it may be converted into the sulphate of iron; that is, into copperas. The ore is broken up, and exposed to the action of air and moisture, when the change takes place, and the lixivium is evaporated to obtain the copperas. In Massachusetts, one can hardly avoid meeting with iron pyrites, and in the western part of Worcester county, the traveller cannot but notice, that nearly all the rocks are coated over with iron rust. This is the result of the decomposition I have spoken of. In Hubbardston, the sulphate is so abundant, that a manufactory of copperas has been established, and I believe success has thus far attended the enterprise. I should presume, that copperas might be manufactured in several other towns south of Hubbardston; as in North Brookfield and Southbridge, although the rocks do not appear as highly impregnated with pyrites in any place as in Hubbardston.

The decomposition of pyrites, in large quantities, often produces a considerable degree of heat; and sometimes pieces of rocks are driven off with explosion. This is one of the sources of those numerous stories which one hears in the country, concerning noises heard, and lights with smoke, seen in the mountains. Such occurrences excite the belief of the existence of valuable mines in the vicinity; but they evince the existence of nothing more than iron pyrites.

Magnetic oxide of Iron.

This is a valuable ore, affording from 50 to 90 per cent, of iron. It exists in several places in Massachusetts, and on the borders of the state.

Hawley Iron Mine.

The principal ore here, is the magnetic oxide, which is very good, and the bed is favorably situated for exploration. The ore does not seem to be abundant, the bed being rarely more than one or two feet wide. It has been wrought to some extent; but the operations are at present suspended. It belongs to Hon. Samuel C. Allen. Micaceous oxide of iron occurs at the same bed.

The same bed of ore makes its appearance a mile or two south of the excavation; and, also as I have been told, two or three miles north, in Charlemont.

In Bernardston.

As already remarked in the postscript to limestone, this forms a bed several feet thick in limestone, dipping at a moderate angle to the south east. When the ore was formerly worked, some complaint was made, as if it did not produce the best of iron. But probably the trials then made were very imperfect. The ore is doubtless very abundant, and I should think well worthy the attention of the iron manufacturer.

In Somerset, Vt.

This bed is similarly situated to that in Hawley, and in the same range of talcose slate, although twenty miles north of the north line of Massachusetts. The ore, yielding 78 per cent of iron, is of the first quality; and this spot is peculiarly interesting on another account, to which I shall refer in the sequel.

In Winchester, N. H.

This bed is only two or three miles north of the line of Massachusetts, and the ore is said to be abundant, though for some reason, the working of it has ceased. The ore very much resembles that from Franconia in New Hampshire.

In Cumberland, R. I.

Dr. Robinson says that he has obtained magnetic oxide of iron, from "most of the thirteen mine holes" which he visited in that town. But the principal bed of ore, lies about two miles north east of the meeting house, and constitutes a large hill. It is obtained with great facility by blasting. It contains however several foreign minerals, so that as it is now worked, it yields only about 30 per cent. of iron. This is probably far less than it contains; for it has a high specific gravity. The ore is smelted principally in Massachusetts. It is owned by General Leach of Easton, and will furnish an inexhaustible supply.

Magnestic oxide of iron is found at other places in Massachusetts; as at Woburn, in a vein of greenstone, associated with sulphuret of Copper; but at none of the localities, in quantity sufficient to make it an object for the miner..

Micaceous oxide of Iron.

This ore, which is found abundantly at Hawley with the magnetic oxide, furnishes perhaps the most elegant specimens in the world; and I know not why it should not produce good iron. Indeed, I believe it has been smelted within a few years, along with the magnetic oxide.

Vein of micaceous oxide in Montague.

Near the mouth of Miller's river is a hill of considerable extent, which appears to be traversed by numerous veins of this ore. The largest which comes in sight, is in the south east part of the hill, at the top of a ledge of mica slate and granite, and is several feet in width. It is favorably situated for exploration, and unless the ore is injured by an occasional mixture of Sulphuret of iron, I do not see why it might not be profitably wrought. Wood is very abundant in the vicinity, and it is not far from Connecticut river. Good micaceous oxide of iron, yields about 70 per cent. of excellent iron.

According to Professor Webster, thin veins of micaceous iron ore, exists in the porphyry of Malden, which were formerly wrought to some extent. It occurs also in graywacke, at Brighton, and in greenstone at Charlestown, according to the Messrs. Danas.

Beds of Brown Oxide cf Iron.

This species of ore is of an excellent quality, and it occurs in the loose soil above the rocks, so as to be easily obtained. Hence it is used to a greater extent, perhaps, in our country, than any other species. A very extensive series of beds of this ore, accompanies the limestone that is so abundant along the western margin of Connecticut, Massachusetts and Vermont; although, as the beds lie upon the clay that is deposited above all the solid rocks, they have no necessary connexion with the limestone.

Beds in Lenox.

These have been explored to some extent in the village, and a mile or two farther west. The ore is good, I believe, but at present it is not used.

Beds in Richmond.

These appear to be numerous and extensive. They are wrought to some extent.

Bed in West Stockbridge.

This furnishes good ore, and is explored more extensively than any other I saw in the county. The farmer who owns it receives thirty seven cents and a half per ton, for the privilege of digging it.

In Salisbury, Ct.

The beds here are very large, and have been extensively explored. The Salisbury iron is known far and wide.

In Bennington, Vt.

Here also the same ore is dug to some extent; and these beds seem to deserve a notice, because they lie, like those in Salisbury, upon the borders of Massachusetts.

In all the beds of brown oxide of iron mentioned above, we find the brown hæmatite in all its forms, the *compact* variety, and the ochrey brown oxide, or yellow ochre. Manganese also is found in them all, and at Bennington, in large quantities; although I have been told, that this locality is nearly exhausted. It was of a superior quality.

The red oxide of iron is found, in comparatively small quantities, at the localities above mentioned. It exists, also, in other places in the State; although it is not, as yet, found in large quantities. Argillaceous oxide of iron is likewise found at most of the hæmatite beds above described.

In Cranston, R. I.

From this place General Leach procures, as he told me, very excellent brown oxide of iron, for the supply of some of his furnaces in Massachusetts; and he represents the bed as inexhaustible.

Argillaceous Oxide of Iron.

This is the most common species of iron ore in Massachusetts. There are several varieties found here. On Nantucket and Martha's Vineyard, particularly at Gay Head, we find the slaty and nodular varieties; and at the latter place, according to F. A. Green, Esq., is found the columnar variety. On the Vineyard these varieties are abundant enough to be an object for the manufacturer; and during the last war, I was told, they were employed in the furnaces on the continent. In a pond, in Sharon, has been found the lenticular variety of this ore.

Bog Ore.

This variety of the argillaceous oxide, is far more abundant than any other, and has been used extensively in the manufacture of cast iron; for which it is chiefly adapted. In the following towns it is found in large quantities: viz. Groton, North, West, and South Brookfield, Carver, Hopkinton, Hardwick, New Braintree, Oakham, Berlin, Sturbridge, Southbridge, Freetown, Dartmouth, Rochester, Troy, Easton and Sharon; and in the following, it exists in greater or less quantities; in Middleborough, Malden, Seekonk, Sheffield, Templeton, Warwick, Williamstown, Greenfield, Northampton, Springfield, Williamsburgh, Dalton, Holland, Wales, Norton, Mansfield, Bridgewater, Stoughton, Spencer, Gloucester, and on Martha's Vineyard; indeed I can hardly doubt that more or less of this ore may be found in nearly every town in the State. It was so common that, at length, I ceased to inquire for it, and the localities are so numerous that I have not attempted to exhibit them all upon the Map.

It ought to be recollected, that the process by which bog ore is deposited, is in many places now going on, particularly at the bottom of ponds. The interval between one dredging and another, was so variously stated to me, that I suspect it differs greatly in different places. I presume, however, that it ought never to be less than twenty years. But the fact, that there will be a renewal of the deposit after a certain time is interesting; because it shows that this mineral can never be entirely exhausted.

Gen. Shepard Leach, of Easton, is the most extensively engaged in the iron manufactory of any man in the Commonwealth. He owns one blast and three air furnaces in Easton; one blast furnace in Foxborough, and another in Walpole; and one blast furnace and four air furnaces, in Chelmsford. In these he employs not far from five hundred men. He generally mixes the different sorts of ore, or at least, two or three of them together for smelting. Extensive iron works are also carried on in Wareham. Several furnaces exist in Berkshire, and a few in Worcester county.

The preceding view of our deposits of iron, demonstrates that we abound in this useful metal, and that the demand, for centuries to come, cannot exhaust it.

Ochres, &c. used as paints.

There are two kinds of ochre, the red and the yellow, which are merely pulverulent varieties of the red and brown oxide of iron. The yellow ochre is abundant with our hæmatite and argillaceous ores, and is frequently employed as a pigment. According to Mr. C. T. Jackson, red ochre occurs in Boylston in a bed four or five inches thick, mixed with clay. It has already been mentioned, that the earthy phosphate of iron in Hopkinton, is employed as a blue paint. Prof. Dewey mentions that a yellow earth is found in Williamstown, from which great quantities of yellow ochre are obtained by washing. Dr. J. Porter states, that yellow earth occurs in Monroe, which, when purified, affords a "pale red paint." The process of preparing it he says is now suspended for want of a demand.

Lead.

Several ores of this metal are enumerated by mineralogists, as occurring in Massachusetts; but none is found in sufficient quantity to render it of any statistical interest, except the sulphuret, commonly called *galena;* and all the important veins of this species are confined to the vicinity of Connecticut river. No fewer than thirteen of these occur in that region of sufficient importance to deserve notice.

All these are in mica slate or granite; or they pass from the one rock into the other.

In Southampton.

The vein in the northern part of this town has attracted more attention than any other in the region, and has been several times described. It is six or eight feet wide, where it is has been explored, and traverses granite and mica slate, the matrix or gangue containing the ore, being a mixture of quartz and sulphate of barytes. It has been opened forty or fifty feet deep, in several places, and masses of ore were dug out from half an inch to a foot in diameter. As the vein descends almost perpendicularly into the rock, water soon accumulated in such quantities, as induced the proprietors to attempt reaching the vein by a horizontal drift or adit, from the bottom of the hill to the east. This was a prodigious undertaking, as the opening must be carried nearly a quarter of a mile into the solid rock. It was persevered in however, at a great expense, for a distance of nine hundred feet, when one of the principal miners having died, and the price of lead having fallen two or three hundred per cent, all operations were suspended, and I believe the proprietors wish to dispose of the mine. Had they continued this drift a few feet farther, there is every probability that the principal vein would have been struck, from one hundred and fifty to two hundred feet below the surface. Perhaps, however, the work cannot be successfully and profitably resumed, until the market shall cease to be glutted with lead from Missouri; but as there can be little doubt, that immense quantities of ore may be obtained at this spot, it may then probably be explored with advantage. I do not doubt, however, that those who first examined this mine were mistaken in the opinion, that this vein extends from Montgomery to Hatfield, a distance of twenty miles. Lead may indeed be found at intervals along a line connecting those places. But I have every reason to suppose, that it proceeds from several distinct and independent veins.

The principal ore above described is the sulphuret; but there have been found here also, the carbonate, sulphate, molybdate, muriate and phosphate of lead, along with the sulphuret of zinc, pyritous copper, and fluor spar. Mineralogists will greatly regret, that mining operations have been suspended here, because they were anticipating the development of rich specimens of these and other minerals.

Another vein of *galena* exists in the south part of Southampton, near the line of Montgomery. It appears for several rods on the surface, but is only a foot or two in breadth. A few years ago, efforts were made to open this vein by a horizontal adit, but the proprietors have become discouraged and abandoned the undertaking.

In Northampton.

This vein is only a short distance north of the principal vein in Southampton, above described. The gangue is radiated quartz, and the walls are mica slate. Yellow blende or sulphuret of zinc abounds here; and the vein was formerly explored to a considerable depth. It is several feet wide.

In Williamsburgh.

The first galena vein to be noticed in this town, lies near the southern part; extending indeed into Northampton. Its width cannot be ascertained, being covered partially with soil. The gangue is quartz; but the galena is not abundant near the surface, and no exploration has been made. Other minerals occur here which render the place interesting to mineralogists.

The second vein is near the north-eastern part of the town, and probably extends into Whately. It is two or three feet wide, and the gangue, as in nearly every other vein of lead in this region, is quartz. Manganese is found in the same gangue.

A third vein of quartz with galena, occurs in this town, a mile or two north east of the one last mentioned. The quartz, however, appears only in loose masses on the surface, but to such an extent, as can be explained only on the supposition, that a vein exists in the rock beneath the soil. Pyritous copper is found in connexion with the galena at this place.

In Goshen.

According to the statements of Mr. Alanson Nash, who has given a map and description of the lead veins and mines of Hampshire county, in the twelfth volume of the American Journal of Science, the same indications of a galena vein appear a little west of the centre of Goshen, as those mentioned in respect to the third vein in Williamsburgh just noticed, viz. the occurrence of masses of quartz containing galena. The rock in the region is mica slate and quartz.

In Whately.

In this town are three distinct veins, containing lead. One is about half a mile east of the second vein described in Williamsburgh. It extends a short distance into Williamsburgh, and more than a mile into Whately. In its whole course, but particularly at its southern part, it contains oxide of manganese along with galena.

A second vein, three or four feet wide, exists in a high ridge of granite towards the south west part of the town. It may be traced along this ridge about three quarters of a mile.

The third vein is in the north-west part of the town, extending some distance into Conway. Galena, in quartz, is the only ore that appears on the surface. The width of the vein is six or seven feet, and it traverses both granite and mica slate. It runs along the western margin of a high hill, so that if it should ever be explored, a lateral drift would be easily made.

In Hatfield.

About two miles west of the village in this town, we find a vein of sulphate of barytes, from one to four feet wide at the surface, running in a north-westerly direction and containing galena. A shaft has been sunk in two places, from fifteen to twenty feet deep; and the vein was found rapidly to widen in descending. The immense quantity of barytes found here, gives the locality a peculiar interest to the mineralogist.

In Leverett.

Although this town lies on the eastern side of Connecticut river, yet the granite and mica slate, occurring there, exactly resemble the same rocks found on the west side of the river; and there can be no doubt that both belong to the same general formation. Two veins, the ore being chiefly galena, are found of precisely the same character as those on the opposite side of the river. That in the south east part of the town is in granite, not more than a foot or two wide at the surface, and the gangue is sulphate of barytes. The other is a mile and a half to the north of the first; the gangue is quartz, and there is almost an equal quantity of galena and pyritous copper; blende also occurs in small quantities. This vein is several feet wide, and runs through granite and mica slate. Both this and the one first mentioned, have been explored to the depth of a few feet.

It is impossible to form any confident opinion as to the probable quantity of lead, which is contained in the several veins which have been described, except, perhaps, in regard to that in Southampton, which has been explored to a considerable extent. In many instances appearances at the surface are quite favorable; but whether the veins become wider, like that in Hatfield, or narrower, as they descend, can be determined only by actual exploration. Of one thing, however, I think we may be assured, from the facts that have been stated; viz. that the central parts of Hampshire county contain extensive deposits of lead, which may be of great value to posterity, if not to the present generation. Probably many more veins will hereafter be discovered, since little examination has been made with a view to bring them to light.

Copper.

This valuable metal occurs in numerous places near the junction of the greenstone and sandstone, in the valley of the Connecticut, between New Haven and Vermont. Several veins of copper ore are found in Connecticut; and the only one in that state, that has been explored to any considerable extent, lies on the borders of Massachusetts, viz. in Granby. It has long been known under the name of Simsbury mines, although it is within the limits of Granby. Many years ago, before the war of the revolution, I believe, this vein was explored to a considerable extent. Afterwards the Government of Connecticut made use of the abandoned shafts and galleries for a State prison. Since the removal of this prison to Wethersfield, the exploration has been resumed, by a new company, I believe, and, I am told, with success. So far as I could ascertain from specimens, which I found there several years ago, and from some recently obtained, the principal part of the ore is the gray oxide, associated, however, with the green carbonate.*

In Greenfield.

In the north eastern part of this town, on the banks of Connecticut river, are two veins of copper, about a mile apart; the most northern one being about one hundred rods below the mouth of a small stream, called Fall river, and the same distance in a direct line from the cataract in Connecticut river, sometimes called Miller's Falls; but lately and more appropriately, Turner's Falls. These veins are several feet in width, and they pass into a hill of greenstone

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* They now find the compact red oxide, as is said, in great abundance.

on one hand, and under the river, on the other hand, into sandstone. The gangue is sulphate of barytes and toadstone, and the ores are the green carbonate and pyritous copper. Actual exploration alone can determine whether these veins might be profitably worked.

On the most southern of the small islands, in the middle of Turner's Falls, has been found pyritous copper, of a rich quality, and in considerable quantity. Indeed, several varieties of the sandstone rocks in the vicinity, appear to be considerably impregnated with copper.

Pyritous copper is associated with iron, in a vein, in greenstone, at Woburn; but not, probably, in a sufficient quantity to be worth mining. At several places in Cumberland, R. I., where excavations were formerly made, are found gray oxide of copper, and pyritous copper with the green and blue carbonates.

Zinc.

The sulphuret of this mineral occurs, as has already been noticed, in several of the lead veins in Hampshire County, and in some of them in sufficient quantity, no doubt, to be wrought with advantage, should these veins be ever opened. Those in Southampton, Hatfield and Leverett, abound most in this ore. It is useful in the manufacture of brass and white vitriol.

Manganese.

In a metallic state this mineral is of no use; and indeed, it is reduced to that state with great difficulty. But in the state of oxide, it is extensively employed, both to remove color from glass and to impart colors; also in painting porcelain and glazing pottery, and still more extensively within a few years, in the manufacture of the chloride of lime, now so generlly used in bleaching and for disinfection.

At least two ores of manganese abound in the western part of Massachusetts and on the borders of New Hampshire. It has been already remarked, that more or less of the gray oxide exists in the iron beds of Berkshire and Bennington, Vt. In the vicinity of Connecticut River, however, or rather on the eastern slope of Hoosac mountain, distinct veins and beds of manganese are found.

In Plainfield.

Beds of the oxide of manganese occur in two places in this town—one a mile west of the center, and the other near the south-west corner of the town; and both in talcose slate. Two ores are associated at both these places, viz. the common gray or black oxide and the silicious oxide; the former investing the latter as a black crust, and most probably proceeding from its decomposition; while the latter, when newly broken, is of a delicate rose red. I suspect the silicious oxide predominates at these places; and from these beds, probably came by diluvial action, those numerous rounded masses of silicious oxide in the vicinity of Cummington meeting-house; although a deep valley intervenes and the distance is three or four miles. An attempt was made, some years ago, to explore one of these beds, under the impression that the ore was iron. But how extensive either of them is, it is difficult to determine, as each seems to consist of a number of small beds—or rather the ore is interlaminated with the slate. The occurrence of so much silicious oxide at these localities, is very interesting to the mineralogist, because this ore is so rare in Europe.

In Conway.

A distinct vein of the black oxide of manganese several feet wide occurs in the southeast part of this town, the gangue being quartz. It has not been explored at all; nor is the manganese ore very abundant at the surface. I do not doubt however, that this ore may be found here in large quantities.

In Hinsdale, N. H.

An extensive bed or vein of the black, and silicious oxides of manganese have been found in this town. It appears near the top of a hill and the adjacent rocks are not visible. The ore strongly resembles that from Plainfield.

In Winchester, N. H.

Between one and two miles east of the center village in this town, may be seen large quantities of the black and red oxides of this metal of the same character as in Hinsdale. These localities have, as yet, attracted no attention except from a few mineralogists. My information and specimens were furnished me by Mr. John L. Alexander of Winchester.

Tin.

I am able to say with perfect confidence that this interesting metal exists in Massachusetts; but can add little more. I found only a single crystal of its oxide, weighing 50 grains. But this I dug myself from a block of granite in the north-east part of Goshen, and on reducing it to metallic tin, it corresponds exactly in every respect with that metal from England. I have never been able to find any more specimens, but it ought be to borne in mind that in England, according to a geological writer of that country, " it is generally in the vicinity of a vein of tin ore, that disseminated grains of tinstone are found in the rock."

Silver.

The only place in the state where this metal has been discovered, is at the Southampton lead mines; it there exists in a small proportion —only 12½ ounces to the ton, in the galena. This is a little greater than the average proportion in the English lead mines: but it is hardly worth the labor of separating it. It is not improbable that when several other ores in the state, such as arsenical iron, sulphuret of iron, and zinc, shall be accurately analyzed, they will be found, as in other countries, to contain a larger proportion of silver. I would however, rather repress than encourage, farther researches for this metal; for as I shall soon have occasion to state more fully, greater expense has been incurred, and more weakness and folly exhibited in such researches, than the community is generally aware of.

Gold.

It may perhaps excite a smile, to see gold occupying a place in a description of the minerals of Massachusetts. It has not indeed been found in this state; *but I am able in this place, to announce the existence of a deposit of this metal, in the southern part of Vermont;* and I feel no small degree of confidence, that it will be found in Massachusetts. A statement of the grounds of this belief, may save me from the charge of extravagant expectations.

I have already described an iron mine, as occurring in Somerset, Vermont. It is owned by S. V. S. Wilder, Esq. of Brooklyn, New York, who has erected a bloomery forge near the spot. Sometime ago, one of the workmen engaged in these iron works, saw in the American Journal of Science, a suggestion of Professor Eaton of Troy, that since the gold of the Southern States, and of Mexico, is in talcose slate, we might expect to find it in the same rock in New England; especially about the head branches of Deerfield river. He commenced an examination in a brook near the mine, and was soon rewarded by the discovery of a spherical mass of gold, of the value of more than a dollar; afterwards he found other small pieces. At the request of Mr. Wilder, I visited this spot a few weeks ago, and found that an individual conversant with the gold mines in the Southern States, and acquainted with the process of washing the metal from the soil, had just been examining the region now spoken of. The result was a conviction, that over several hundred acres at least, gold was common in the soil. In a bushel of dirt collected in various places, he found about three pennyweights of very pure gold. Mr. Wilder proceeded himself to exhibit to me an ocular demonstration of the existence of gold in the soil, by washing for it. From about six quarts of dirt, taken a foot below the surface, we obtained (although not very skilful in manipulations of this sort) twenty or thirty small pieces, weighing about seven grains. Indeed, by the aid of my knife, I picked two or three pieces from the dirt.

The iron ore is in beds in distinct talcose slate; and a considerable part of the ore is the brown oxide, and contained in a porous quartz. In this quartz, were found several spherical pieces of gold, scarcely larger than a pigeon shot. Whether it exists, as in the Southern States, in finer particles in the yellowish iron ore, has not been ascertained. But specimens of the quartz and iron at this place, cannot be distinguished from what is called gold ore, at the gold mines in Virginia, and North Carolina. Indeed, a suite of specimens from the Somerset iron mine, could not be distinguished, except by labels, from a similar suite from the south.

In every case in which gold has been found at this place, in the soil, it was accompanied by more or less of iron sand, and some distance north of the mine, neither could be found; but how far to the South and East it occurs, has not been ascertained. I am inclined however to believe, that the gold at this locality, will be found to be always associated with the iron.

We were told at Somerset, that several years ago, a mass of gold was found in the bed of Deerfield river, three or four miles to the south of the mine, which was sold for sixty eight dollars, and we had no reason to doubt the statement. Certain it is, that a few years since, a piece was discovered by Gen. Field, weighing eight and a half ounces, in New Fane, a town twelve or fifteen miles east of Somerset.

Upon the whole, it appears to me that the facts above stated justify the conclusion, that there exists a gold region in the lower part of Vermont, of considerable extent and richness. It may be found to be very extensive, and probably it is not confined exclusively to the talcose slate formation; for New Fane, I believe, contains but little of this rock. The region west of Somerset is little known: the iron mine there, lies at the foot of the Green Mountains, and it is chiefly a mountain wilderness for sixteen or seventeen miles west of this spot.

The talcose slate formation, containing the iron and gold in Somerset, extends southerly, nearly across the state of Massachusetts; passing through the towns of Rowe, Charlemont, the settlement called Zoar, Florida, Savoy, Hawley, Plainfield, Cummington, Worthington, Middlefield, &c. Indeed, I know of no place, where the formation is so perfectly developed in its characters, as in Hawley and Plainfield. There is then, surely, as much ground for presuming that gold will be found in Massachusetts, as there was for predicting its discovery in Vermont. If an iron mine and porous quartz, with oxide of iron, be necessary, we have these in Hawley, in the talcose slate. And it ought to be recollected, that the Vermont gold was found at the source of Deerfield river, and that this stream runs directly south into Massachusetts; and it would be rather strange, if so violent a torrent did not carry some of the diluvium, containing gold, at least as far as the limits of this state. The place where I suppose gold might be found, in Massachusetts, would be in the vicinity of the Hawley iron mine, or the Plainfield beds of manganese, or along the banks of Deerfield river, in Monroe, Florida, Zoar and Charlemont: nor should the region around the limestone and iron ore, in Bernardston, be forgotten, in an examination for this metal, although the rock there is not talcose slate. Talcose slate occurs also in many other places in the state; particularly in Berkshire county, on the Taconnic range of mountains, Saddle mountain, and other eminences; and here also are porous quartz and oxide of iron. I have found time to make only a slight examination for gold, in one or two of the places above mentioned. The surest method of determining the point, would be to obtain some one, who is conversant with the gold regions at the South, and with the mode of washing it, to examine the places I have mentioned. It may indeed be doubtful, whether the discovery of gold would be a public benefit; since, as your Excellency has well observed, it might lead to "the greedy pursuit of this uncertain gain, and to the sure sacrifice of habits of industry and economy, and virtuous self-denial, which the ordinary pursuits and requirements of business induce. We may doubt even, whether the grass-covered hills of our own New England, are not a better source of wealth and contentment, than the precious metals which the earth embosoms." But, however political economy might decide these questions, I suppose there are few individuals who would willingly shut their eyes upon gold mines; and therefore I have made these suggestions on the subject, to prevent expenditure upon useless and ill-planned projects, in search of this precious metal.

Idle search after Gold and Silver.

Were the history of the wild and ill-directed efforts that have been made, even in Massachusetts, in search of the precious metals, to be written, it would furnish many striking illustrations of the importance of your Excellency's suggestions. Permit me here to state a few facts on the subject.

The large quantities of the precious metals carried to Europe from South America, soon after its discovery, naturally produced some expectation of finding similar treasures here. But I cannot learn that our forefathers expended large sums in making excavations, where there was no reasonable prospect of finding any thing valuable. It was reserved for their descendants to exhibit a credulity and superstitious ignorance on the subject, that are both lamentable and ridiculous.

Perhaps, at the present day, a belief in the mysterious virtues of the mineral rod, is the most common of these delusions. Probably many of our intelligent citizens can hardly credit the statement, that there are men in various parts of the state, who profess not a little skill in this enchantment, and are not unfrequently sent for, one or two days journey, to decide whether there be ore or springs of water in a particular place. In general, but not always, these professors of divination belong to the most ignorant classes in society; for not long since, a venerable and respectable man of good education, sincerely thought it his duty occasionally to peregrinate with his divining rod, because *it would work in his hands;* and not a few very intelligent men have a secret belief, that the branches of a witch hazel are attracted downward towards mineral substances, when in the hands of a certain individual.

The following train of circumstances often takes place. A man, ignorant of mineralogy, finds upon his farm, a specimen of iron pyrites, or yellow mica, or galena, which he mistakes for gold or silver. Even if he shows it to a mineralogist and is told that he is mistaken, he suspects that his informant is deceiving him, in the hope of getting possession of the prize himself. He resolves to begin an excavation. And he sees enough, in the shining particles of mica and feldspar that are thrown out, to buoy up his hopes, until his purse is well nigh drained.

It was probably in some such way, that the excavations were made in Worcester and Sterling, at the mines of arsenical iron and carbonate of iron; although, in these cases, there would be sufficient ground for obtaining some of these ores, since they do sometimes contain silver. But I cannot conceive why such extensive excavations were made, when a chemist might have easily settled the question as to their nature, by analyzing 100 grains of the ore, unless it was on the erroneous supposition, which I find to be common, that metallic veins generally become much richer and larger, and even change their contents, as they descend into the earth.

The decomposition of iron pyrites, producing heat and sometimes explosion, is supposed by some to be a strong indication of mineral riches in the earth beneath. The man of the witch hazel rod is called, and if he confirms the suspicion, as he usually will, the excavation is commenced; nor is it suspended until a heavy draft has been made upon the man's pecuniary resources. An extensive excavation was made, many years ago, I am told, in Hubbardston, and from the character of the rock there, I suspect that iron pyrites gave the first impulse to the undertaking. In Pepperell, an individual has been engaged for several years, in pushing a drift into the rocks, which he has penetrated eight or ten rods; although individuals who have visited the spot, (I have not,) can discover nothing but iron pyrites.

In the year 1815, an individual succeeded in getting a company formed and incorporated, with a capital of eighty thousand dollars, called the Easton lead and silver mining Company. The fruits of their labor may be seen in an excavation, in red granite, nearly one hundred feet deep, at present nearly filled with water. I could not find a particle of ore, of any kind, in the fragments blasted out. A final stop was put to the work, by the killing of two men in blasting.

Forty years since, a shaft was sunk in Mendon, in search of the precious metals. A little specular oxide of iron occurs at the place.

Not many months since, an individual called upon me, with specimens of black blende or sulphuret of zinc, found in a neighboring town, and which he strongly suspected to be silver. I informed him of its true nature, and seeing that the vision had got strong hold upon his mind, I did all in my power to persuade him not to engage in searching for the ore. But the only effect was to stimulate him to commence an exploration with more ardor. The zinc was found in a loose piece of rock, lying in the field. The man's impression was, that even if that ore was of no use, it indicated something valuable beneath. Accordingly, he commenced digging. Ere long his faith was strengthened, by some one's discovering a light, during the darkness, near the spot; and the last time I heard from the man, he had penetrated the soil about seventy feet.

The following case has been stated to me on such authority, that I do not doubt its correctness.

Some forty or fifty years ago, a farmer residing not far from the center of Massachusetts, knocked off from a rock upon his farm, a piece of ore, which he sold in Boston for a considerable sum, as a rich ore of silver. From that time till the day of his death, he searched in vain for the rock from which it was broken. The inference, which he drew from his ill success, was that Satan, (who is thought, by multitudes, to have unlimited power over the mineral treasures of the earth,) had concealed or removed the precious vein. Conceiving, however, that some of his posterity might have more interest with that personage than himself, he reserved to them the right of digging the ore, in the instrument which conveyed away his title to the land. His posterity were not forgetful of the reservation; but they were convinced that it would be of no use to them, unless they could meet with some individual, who had *entered into a league*, (as the phrase is with the class of people I am describing,) with his Satanic majesty. Last year they heard of such a man, a German, in Pennsylvania, who had obtained possession of a wonderful glass, through which he could discover whatever lies hid beneath the soil. The German was persuaded to visit the spot, and when I passed through the place, a little more than a year ago, an excavation was about to be commenced under his direction. But I have not learned how the enterprise succeeded.

Still more ridiculous than the opinions and practices above mentioned, are some still existing in a few places in the State, relative to deposits of money, said to have been made by one Kid, a celebrated buccaneer of early times. The statement is, that he frequently ascended our streams a considerable distance, and buried in their banks, large sums of money. These are supposed to be guarded with sleepless vigilance by the personage mentioned before. But by the use of certain incantations, while digging for the treasure, it may be wrested out of his hands; for instance, perfect silence must reign during the operation, unless it be broken by the reading of the Bible, and all must be done in the night. The last instance of the practice of this mummery, which I have heard of, occurred a few years since on one of the branches of Westfield river. A hundred days' works were expended upon the enterprise before it was abandoned. At one time those employed in this work were greatly discouraged, by the intrusion of my informant, who, in spite of all they could do by gestures, broke silence, and thus dissolved the charm. At another time, courage was revived by finding an iron pot, containing some bits of copper, deposited there, the day previous, by some boys who had learned what was going forward.

I have given these rather mortifying details, partly because I doubt whether nine tenths of our population are aware of the existence of such opinions and practices among us; and partly in the hope that the exposition may be instrumental in entirely eradicating them from the minds of those who have been thus deluded. For, like night fogs, they need only to be brought into the light of day to be dissipated.

Concluding Remarks.

In concluding this summary of the economical geology of Massachusetts, I cannot but allude to the very imperfect development which has hitherto been made of our mineral resources. Judging from what we know at present, our granites, marbles, and other rocks, useful in architecture, are undoubtedly the richest of these resources. Yet it is only a few years, since these rocks (with the exception of some quarries of marble,) have been employed at all for building; and even now, only a few beds, and these very possibly not the best, have been opened. In the vicinity of Connecticut river, the inhabitants are just beginning to learn that they have beautiful granite in their own hills and mountains. The Berkshire marbles are wrought on a stinted scale, compared with what they might be, were a railroad to furnish the means of an easy transportation to the Hudson. And as to our porphyries and serpentines, various and abundant as they are, it is rare to meet with a single polished specimen. Our mineral veins and beds, with the exception of a few mines of iron, and one of lead, lie as yet almost untouched, and probably many of them undiscovered.

These facts ought to be kept in mind in forming an estimate of our mineral resources. Yet imperfect as is our acquaintance with these, I think we need not fear a comparison, in this respect, with any other part of the country. Other States possess particular minerals which are more valuable and interesting, and calculated to awaken public attention more than ours; yet where is the territory abounding in a greater number of rocks and minerals, of real and permanent utility, whose quality is excellent and whose quantity is inexhaustible? They are, indeed, of such a character, that they will increase in value for several generations to come. That is, we may calculate that the demand for them will increase during that period, and this demand will lead to the discovery of varieties really more valuable.

Thus far we have regarded our geology only in an economical point of view. I hope to show in the subsequent parts of my Report, that it is not less interesting to the man of taste and science.

Respectfully submitted,

EDWARD HITCHCOCK.

Amherst College, Jan. 1st, 1832.

P. S.—Since the above account was in type, I learn, that in Leominster, in Worcester county, there is a rich alum rock. It appears to be a decomposed mica slate, and contains abundance of beautiful plumose, or feather-form alum, like that of Milo, one of the Grecian isles, mixed with the green crystals of copperas, or sulphate of iron. There can be little doubt, that it proceeds from the decomposition of iron pyrites in the rock; the acid, formed from the sulphur, then unites with both the iron and the alumina, and thus forms the two salts. If these salts, and especially the alum, or the materials, which by proper treatment, may easily produce it, should prove to be abundant, the discovery may become practically important. I have not seen the specimens, but derive my information from Prof. Silliman, who has examined them; and who remarks, that it is common in this country, to find alum, formed in mica slate; a fact which appears to have been scarcely observed in Europe, where a variety of clay slate, or shale is the common alum rock.

The Rev. Mr. Boutelle, of Leominster, can give more particular information as to the local facts.

Art. II.—*On the Hessian Fly; by* Dr. Joseph E. Muse.

Cambridge, E. S. Md. Dec. 27, 1831.

TO PROFESSOR SILLIMAN.

Dear Sir—There is perhaps, no branch of natural science so much neglected, as that of entomology; and none, that more imperiously calls for our attention: this is most emphatically true, in regard to those families of insects, that are most destructively multiplying, and preying upon the staple crops of our country, and rendering fruitless, the best energies of our population, in that department of human industry, which, from the creation to the present time, has been recognized as the basis of individual comfort, and national wealth.

Though sceptics in political economy, may in the abstract, entertain doubts of the latter; yet, this proposition in all its parts, will receive the common consent of mankind; and affords a striking instance of negligence, in matters of high importance, when many objects of idle curiosity are earnestly pursued.

My attention has been drawn into this course of thought, by the rapid increase of the "Hessian Fly" and its most disastrous ravages on our wheat crops; it may be safely affirmed, that in the last season, two thirds of the best hopes of the grower of this grain, were disappointed, by this little enemy, whose blasting influence was felt in different degrees, throughout the whole extent of the wheat growing section of our country.

It is said that this insect, notwithstanding its vulgar name, (Hessian) is not known in Europe; nor is it in South America; it is peculiar to those portions of the United States, and Canada, which produce wheat; and its first advent is dated about fifty years ago: beyond which period, there appears to be no notice of such an insect, extant.

To defeat this vandal foe, it is essential to become acquainted with its habitudes, and character; and without further apology, I design to offer my small contribution to this end, by the following history of facts, recently acquired, which I believe to be the more necessary, as the insect in question, from the diminutive size, in its *parent* state, has wholly eluded the perception of all, with whom I have conversed; and of myself, heretofore, although frequently in quest of it.

In my stack yard, I had observed much scattered wheat, which had vegetated and grown luxuriantly, to be withered, and declining, about the 1st of September, and on examination, I discovered, that it was uniformly throughout the yard, loaded with the chrysalids of the "Hessian Fly": I dug up a small sod of the wheat, without regard to selection, and placed it in a flower pot, under an inverted glass jar, on the mantle piece of my sitting room, where it might have a warm temperature, adapted to its early development; in a few weeks, the insects began to exhibit themselves in their parental robes: and I have frequently and diligently, with the aid of a good microscope, examined them, in their various stages of progression; and obtained the following results.

The "Hessian Fly" belongs to the order "Hemiptera," genus, "Aphis": and I take the liberty to characterize it, by the specific name "Aphis Tritici," in place of the vulgar one, which is founded in the erroneous opinion of its origin.

The fully matured insect is about the size of the "flea" ("pulex";) its head is armed with an inflected rostrum, about one half the length of the antennæ, which are long: the thorax, and a triangular scutellum are black, and separated by a slight but distinct spinous ridge: tergum, light yellow; posterior segment of the abdomen, has a bright yellow band from which issue two small horns, which latter, indeed, are found in all the varieties of aphides as organs of excretion, for the honey dew; wings short and deflex; exterior portion of the superior, rich black, with yellowish maculæ; breast, belly and legs, very black.

Some specimens which came under my observation, (I presume the most fully matured, by frequent castings,) were the most splendid insects, I ever beheld; excelling in the disposition, and brilliancy of colors, the much extolled "Buprestis," or, the beautiful "Cicindela."

These insects frequently cast off their exuviæ; perhaps indefinitely under circumstances: the wings are not unfolded to view, until the exuviæ are cast; in this respect, agreeing with another family of the same order, the "Gryllus," (grasshopper;) and like this, too, obviously at no period, is it capable of a long flight: every casting which I observed, gave a more intense hue to the colors of this insect; the three which I could identify, were performed in eight or ten days: in its infant stage of maturity, if I may use the apparent solecism: or, when it has first emerged from its chrysalis, it is wholly of a whitish color, having the appearance of some aurelias; except, that its legs are developed; its inchoate wings are distinctly indicated, but tied down, as with a fine web.

Whether the insects are viviparous or oviparous, I could not satisfy myself; and it is not essential to any useful purpose, as the larvæ in a few hours from their deposit, make their escape from the pellicle in which they were glued down to the leaf, or stalk; and crawl down immediately to the nearest joint, where they fix their proboscis in the plant; suck, and grow rapidly in a warm temperature, and remain in the same position, assuming the chrysalis in a few weeks: from which state, the early deposits, in a warm season are speedily released; but the chrysalids, from a latter deposit, continue in their shells, through the winter, and are not developed until the spring, when the approaching heat soon brings them into parent existence, to make their new deposits, which latter by the 10th or 15th of May, make a woful demonstration of their rapid growth and progress, by the decline of the wheat plant, upon which they had been operating; having then passed through the larva into the chrysalis, the shell of which is hard, and pressing upon the tender shoot interrupts the ascent of the sap, they thus mechanically affect the health and life of the plant, more than by the quantity they had consumed by absorption.

The number of these insects obtained from my small sod, of a few inches only, of wheat, is incalculable and incredible, and furnishes grounds to affirm, that the stack yard, from which it was taken, containing several square perches of this nidus, and nutriment for them, had I not soon after the discovery scraped off and burnt the offal, was sufficient to have produced myriads of swarms, to the inevitable destruction of my own, and my neighbors' crops.

This fact, then, should teach the agriculturist, the necessity of preserving their stack yards, and other places, clean, and free from vegetating scattered wheat; and clearly establishes one great source of this evil, or rather of the perpetuation and increase of the insect, which has excited universal astonishment and dismay, throughout our wheat growing district.

Another source may be found, in the practice, also otherwise reprehensible, of fallowing for a second successive crop, upon wheat stubble; much scattered wheat thus prematurely vegetated, affords sustenance and security to these insects, which might have considerably perished, at the crisis when this operation is generally performed, from the absence of a continuous medium of perpetuation.

The peculiar and, I believe, exclusive prey of this insect is the green leaf and stalk of wheat; analogy, independent of my experiment, will teach us that this diminutive insect, like the rest of the aphides, although they propagate millions, are mere ephemera, in point of existence, in the *parent* state; were the casual vegetation of this plant, carefully avoided between the harvesting of the old crop, and the seeding of the new, a period, in our climate, of about three months; and the latter operation deferred till the commencement of frost, the parent swarms would most probably perish. An interval fatal to their increase, would, indeed, be the necessary and gratifying consequence; and, as no parent insect survives the winter, the practice, if universally adopted, might secure the final extinction of this variety of the family in our country. Not so with those various species which inhabit *perennials*, whose sustenance cannot be withdrawn or suspended; but with the "Aphis Tritici" it is unquestionably practicable, if the course be seriously undertaken, and diligently pursued for a few years, which should be considered a duty, that every grower of wheat owes to his neighbor as well as to himself.*

Art. III.—*Mathematical Papers; by* Elizur Wright, Esq.

No. I.—*An improvement suggested in field Surveying.*

In the common method of computing the area of a field, a meridian line is supposed to be drawn at some assumed distance from the commencing corner, and the number expressing this distance is placed at the head of the column of Meridian Distances. But, if this meridian line is made to bisect the first side, the number which constitutes the first factor becomes 0, and consequently the first product vanishes. Should the lots to be surveyed be allowed at a medium to consist of five sides, nearly one sixth part of the labor of computation will be saved. This will probably appear to Surveyors who are not prepossessed in favor of a previous method, to be an acquisition not to be neglected, especially, if in other respects it is equally eligible. The improvement is comprehended in the following directions.

In the field-book make two columns, in the first of which insert the points of compass, and the sides of the field as they are surveyed, together with a description of the boundaries. From a tra-

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* While Dr. Muse's paper was passing through the press, we are assured that the Hessian Fly has heretofore been referred, by writers on Natural History, to the order Diptera, genus Tipula; and that Blumenbach (Man. of Nat. Hist. by Gore, p. 224,) calls it *Tipula destructor*, and refers to the Phil. Jour. of Nat. Sci. 1817, tab. 3. We are informed also that Dr. Akerly, of New York, some years since, published an able paper on this insect, but the Journal containing it is not at hand.—*Ed.*

verse table find the northings and southings, and the eastings and westings; placing the northings and southings in the first column, and the eastings and westings in the second column. When the northings are considered as affirmative quantities, the southings will be negative; and when eastings are affirmative, westings will be negative; but when the southings are considered as affirmative quantities, the northings are negative, and when westings are affirmative, eastings will be negative.

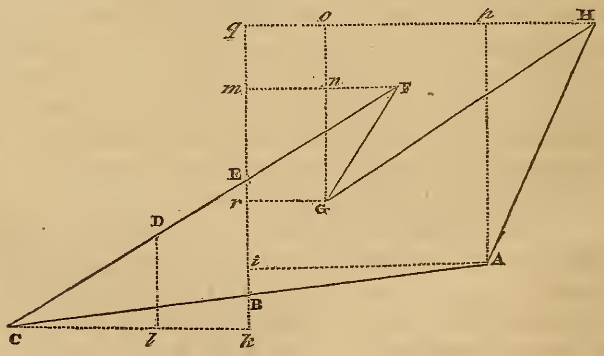
In the second column put 0.00 for the factor corresponding to the first side. Suppose westings to be negative. When the departures of the first and second sides are both eastings, or both westings, take their sum, placing the negative sign before it, when the departures are westings; but when one is an easting, and the other a westing, take their difference, placing the negative sign before it, when the greater number is a westing. The number obtained by this operation will be the factor to be multiplied into the northing or southing belonging to the second side. Following the same directions, take, again, the sum or difference, as the case may be, of this factor and the departure of the second side.

When the number last found and the departure of the third side are both eastings or both westings, take their sum, placing the negative sign before it, when they are westings; but if one is an easting and the other a westing, take their difference, placing the negative sign before it when the greater number is a westing. The number thus obtained will be a factor to be multiplied into the northing or southing belonging to the third side. Observing the foregoing directions, take again, the sum or difference, as the case may be, of this last factor and the departure of the third side. In like manner proceed with all the remaining sides. Here it is obvious that according to the rule of adding affirmative and negative quantities in algebra, each departure is twice added, once before and once after multiplication. This circumstance may assist in remembering the rule.

At the bottom of the first column put the letters NE, SW, and at the bottom of the second column NW, SE. These letters denote that the products, whose factors are northings and eastings, or southings and westings, are to be placed in the first column; while those whose factors are northings and westings, or southings and eastings are to be placed in the second column. Add the products in the first column together; and also those in the second; take the difference of these sums, half of which will be the required area of the field.

C. S. N. S.	E. W.	C. S. N. S.	E. W.
S. 84° W. 26	−25.86	S. 84° W. AC	−A*i*−*k*C
	00.00		0.00
2.72	−25.86	*ik*	−A*i*−*k*C
N. 59° E. 25	21.43	N. 59° E. CF	C*k*+*m*F
	−4.43		−*lk*
12.88	17.00	*km*	2*m*F
S. 34° W. 8	−4.47	S. 34° W. FG	−F*n*
	12.53		2*m*F−F*n*
6.63	8.06	*n*G	2*r*G
N. 59° E. 18	15.43	N. 59° E. GH	*o*H
	23.49		2*r*G+*o*H
9.27	38.92	G*o*	2*q*H
S. 27° W. 14.37	−6.53	S. 27° W. HA	−H*p*
	32.39		2*q*H−H*p*
12.80	25.86	*p*A	A*i*+*k*C
NE. SW.	NW. SE.	NE. SW.	NW. SE.
217.7523	57.0584	2GH*qr*	2DE*kl*
	83.0739		2FG*rm*
	414.5920		2HA*iq*
	554.7243		
	217.7523		
	336.9720		
	168.4860		

Geometrical illustration.



Take a plot ACFGH of the field. Draw the meridian line *qk*, bisecting the first side AC. Also the departures A*ik*C, C*km*F, F*n*, *o*H, H*p*; the northings, *km*, G*o*, and the southings, *ik*, *n*G, *p*A. Draw D*l* parallel with E*m*, making the triangle CD*l*, equal to EF*m*.

From the sum of the products in the column N W, S E, subtract the product in the column N E, S W, and divide the remainder by 2 according to the rule, and we obtain,

$$DEkl+HAiq-GHqr+FGrm=ACFGH.$$

Demonstration.

$$lk\times km=2DEkl.$$
$$(2mF-Fn)nG=2FGrm.$$
$$(2rG+oH)Go=2GHqr.$$
$$(2qH-Hp)pA=2HAiq.$$

Hence, subtracting $2GHqr$, and dividing by 2, we have,

$$DEkl+HAiq-GHqr+FGrm=EDlkiAHGFm.$$

For EFm substitute its equal CDl, and for BCk substitute its equal ABi, and we have, $DEkl+HAiq-GHqr+FGrm=ACFGH.$

No. II.—The propositions contained in this paper are obvious, and may, perhaps, be found in many treatises on surveying. I have chosen, notwithstanding, to send it for insertion in the Journal of Science, for the purpose of bringing the methods contained in the first and third papers, side by side, that their connexion and relation may readily be seen.

A method of finding the contained angles of a field, having the courses and sides given.

The courses of the two sides, that form the angle, when compared together, admit of the four following variations. viz.

Var. 1. Unlike, like; when letters are $\frac{N.}{S.}$ or $\frac{S.}{N.}$ and $\frac{E.}{E.}$ or $\frac{W.}{W.}$

The contained angle is the sum of the points of compass.

Var. 2. Unlike, unlike; when they are $\frac{N.}{S.}$ or $\frac{S.}{N.}$ and $\frac{E.}{W.}$ or $\frac{W.}{E.}$

The contained angle is the difference of the points of compass.

Var. 3. Like, unlike; when they are $\frac{N.}{N.}$ or $\frac{S.}{S.}$ and $\frac{E.}{W.}$ or $\frac{W.}{E.}$

The angle is their sum subtracted from 180°.

Var. 4. Like, like; when they are $\frac{N.}{N.}$ or $\frac{S.}{S.}$ and $\frac{E.}{E.}$ or $\frac{W.}{W.}$

The angle is their difference subtracted from 180°.

The following rule may be of use to the surveyor, in ascertaining the accuracy with which the courses have been taken.

Find by the foregoing directions all the including angles of a field, taking the remainder, after subtracting an outward angle from 360°, for an including angle; add them together; then to this sum add 360, and divide the result by 90; if the courses have been correctly taken, the quotient will be exactly double the number of angles in the survey without a remainder.

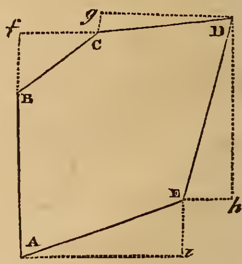
Ex. S. 84° W: thence N. 59° E: thence S. 34° W: thence N. 59° E: thence S. 27° W.

84	59	34	59	27	25
59	34	59	27	84	25
—	—	—	—	—	335
25	25	25∠	32	57	32
		360		180	123
		—		—	360
		335		123	—
					90)900(10

No. III.—*A general method of finding the area of an irregular Polygon, having the sides and contained angles given.*

Suppose the several sides of the polygon AB, BC, CD, DE, EA, to be hypöthenuses of right angled triangles, of which the perpendiculars B*f*, C*g*, D*h*, E*i*, are parallel with the first side AB, with which the calculation commences.

Let the contained angles ABC, BCD, CDE, DEA, be exchanged for the angles *f*BC, *g*CD, *h*DE, *i*EA. These latter may be termed *angles of commutation*, and are obtained in the way hereafter described.



The positions of the bases and perpendiculars, are next to be discovered and designated. The perpendiculars B*f*, C*g* on one side of the bases may be considered affirmative, denoted by A, and the perpendiculars D*h*, E*i* on the opposite side, negative, denoted by N, placed before the angle of commutation; likewise the bases *f*C, *g*D, on one side of the perpendiculars, may be considered affirmative, denoted by A, and the bases *h*E, *i*A, on the opposite side, negative, denoted by N, placed after the angle of commutation.

When a side happens to be at right angles with the first side, the perpendicular vanishes; and when a side is parallel with the first side, the base and angle of commutation vanish: yet, for the purpose of discovering the positions of the subsequent bases and perpendiculars, these evanescent quantities must be brought into the calculation, and expressed by 0.

When one number is either added to another, or subtracted from it, the result is called a *factum.*

Place A before, and after, the evanescent angle of commutation belonging to the first side. Then, the several angles of commutation may be found by the following rule, which contains two cases.

Case I. *When the letters, placed before, and after, the angle of commutation last found, are the same.*

Take the sum of the angle of commutation last found and the given angle, if it be inward; but if it be outward, take their difference.

Case II. *When the letters, placed before, and after, the angle of commutation last found, are different.*

Take the difference of the angle of commutation last found and the given angle, if the given angle be inward; but if it be outward, take their sum.

In both cases, when the factum exceeds 90°, subtract it from 180°; but when it exceeds 180°, subtract 180° from it, and the remainder will be the required angle of commutation.

The position of the perpendiculars and bases may be discovered by inspection; thus,

Case I. *When the factum, last obtained, is less than* 90°.

Prop. 1. If the angle of commutation be subtracted from the given angle, the letters placed before the two angles of commutation last found will be unlike, and the letters placed after, like.

Prop. 2. If the angle of commutation is not subtracted from the given angle, the letters, placed before and after, will be unlike.

Case II. *When the factum, last obtained, is greater than* 90°.

Prop. 1. If the sum of the angle of commutation and given angle be subtracted from 180°; the letters placed before will be like, and the letters placed after, unlike.

Prop. 2. If the sum of the angle of commutation and given angle is not subtracted from 180°; the letters, before and after, will be like.

When the factum is 90°, it may be considered as belonging either to Case I. or Case II.; and when the factum is 180°, it may be considered as belonging either to Prop. 1 or Prop. 2, Case II, each supposition leading to a true result.

From a traverse table, find the bases and perpendiculars of the several sides. Put the bases underneath the sides in the second column, and the perpendiculars in the third column. Prefix N, or the negative sign, to those perpendiculars whose positions are designated by N, placed before the corresponding angle of commutation; and likewise place, or suppose to be placed, N, or the negative sign, before the bases, whose positions are denoted by N, after the corresponding angle of commutation.

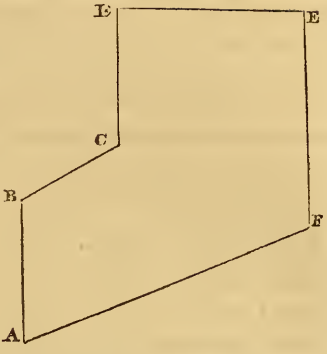
Make the factor in the third column, corresponding to the second side, equal to 0, and let the perpendicular belonging to the second be considered as the first factum resulting from the perpendiculars. Then perform the following operation, for each of the remaining sides. When its perpendicular and the next preceding factum have values of the same kind, take their sum, prefixing the negative sign when they are negative; but when they have values of different kinds, take their difference, placing the negative sign before it, when the greater number is negative. Then the factum thus obtained, and the base belonging to the side, will be factors, to be multiplied together. Again, observing the foregoing directions, take the sum, or difference, as the case may be, of the perpendicular and factum last obtained. Bring the several products, whose factors are AA or NN, into one sum, and the several products, whose factors are AN or NA, into another sum. Take the difference of these sums, half of which will be the required area of the polygon.

Example 1. *The same as in No.* II.

Ang.	S. B.	P.
25°	25	25.00
		—17.75
A. 0 A.	0.00	7.25
25°	8	— 7.25
		0.00
N. 25 N.	—3.38	— 7.25
25° ∠	18	18.00
		10.75
A. 0 N.	0.00	28.75
32°	14.37	—12.19
		16.56
N. 32 N.	—7—61	4.37
123°	26	—23.56
155		—19.19
N. 25 A.	10.99	—42.75
	AA. NN.	AN. NA.
		126.022
		210.898
		336.920
		168.460

Example 2.

FAB = 68° 36′, AB = 8.
ABC = 120°, BC = 6.
BCD = 120° ∠, CD = 7.
CDE = 90°, DE = 10.
DEF = 90°, EF = 12.
EFA = 111° 24′, FA = 16.34



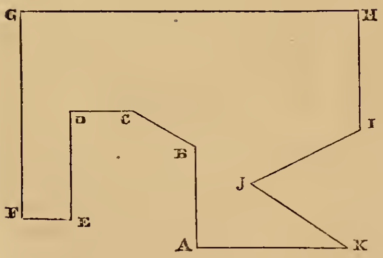
Ang.	S. B.	P.
68° 36′	8.00	8.00
	0.00	—11.00
A.0A.		— 3.00
120	6.00	3.00
120	—5.20	0.00
A.60N.		3.00
120∠	7.00	7.00
180	0.00	10.00
A.0A.		17.00
90	10.00	0.00
	—10.00	17.00
N.90N.		17.00
90	12.00	—12.00
180	0.00	5.00
N.0N.		— 7.00
111 24	16.34	— 6.00
111 24	15.20	—13.00
N.68 36A.		—19.00
	AA.NN.	AN.NA.
		170.00
		197.60
		367.60
		183.80

Beginning at EF we have,

90°	12.00	12.00
	0.00	—18.00
A.0A.		— 6.00
111 24′	16.34	6.00
111 24	—15.20	0.00
A.68 36N.		6.00
68 36	8.00	— 8.00
0 00	0.00	— 2.00
N.0N.		—10.00
120	6.00	— 3.00
120	5.20	—13.00
N.60A.		—16.00
120∠	7.00	— 7.00
180	0.00	—23.00
N.0N.		—30.00
90	10.00	0.00
	10.00	—30.00
A.90A.		—30.00
	AA.NN.	AN.NA.
		67.60
		300.00
		367.60
		183.80

Example 3.

KAB = 90°, AB = 5.
ABC = 120° ∠, BC = 4.
BCD = 150° ∠, CD = 3.
CDE = 90° ∠, DE = 6.
DEF = 90°, EF = 2.5.
EFG = 90°, FG = 12.
FGH = 90°, GH = 18.
GHI = 90°, HI = 7.
HIJ = 120°, IJ = 6.
IJK = 60° ∠, JK = 6.
JKA = 30°, KA = 9.036.



Ang.	S. B.	P.
90	5.00	5.00
	0.00	— 7.00
A. 0 A.		— 2.00
120∠	4.00	2.00
120	3.464	0.00
A. 60 A.		2.00
150∠	3.00	0.00
	3.00	2.00
N. 90 A.		2.00
90∠	6.00	— 6.00
180	0.00	— 4.00
N. 0 A.		—10.00
90	2.50	0.00
	2.50	—10.00
A. 90 A.		—10.00
90	12.00	12.00
180	0.00	2.00
A. 0 N.		14.00
90	18.00	0.00
	—18.00	14.00
N. 90 N.		14.00
90	7.00	— 7.00
180	0.00	7.00
N. 0 A.		0.00
120	6.00	— 3.00
120	5.196	— 3.00
N. 60 A.		— 6.00
60∠	6.00	— 3.00
120	— 5.196	— 9.00
N. 60 N.		—12.00
30	9.036	0.00
	9.036	—12.00
A. 90 A.		—12.00
	AA. NN.	AN. NA.
		25.000
		252.000
	6.000	15.588
	46.764	108.432
	52.764	401.020
		52.764
		348.256
		174.128

Art. IV.—*Description of the American Wild Swan, proving it to be a new species.*

CYGNUS AMERICANUS.

By John T. Sharpless, M. D. of Philadelphia.

Read before the Acad. Nat. Scien. of Philad. Feb. 7th, 1832.

Anas *cygnus ferus*, Linn.—Cygnus *ferus*, Briss.—*Le cygne sauvage*, Buff.—*Elk* or *Hooper Swan*, Ray—*Whistling Swan*, Lath., Pennant—Cygnus *musicus*, Bechst, Bonaparte—*Swan*, Wilson's *list*—*Wapa Seu*, Indians Hud. Bay.

In the 8th No. Vol. 1st. of the Cabinet of Nat. History, by the Messrs. Doughty, published 1831 in this city, in describing the history and habits of the American Swan, I intimated my belief, that this bird was a distinct species from either of the European (Hooper or Bewick, Yarrell) Wild Swans. This opinion I have since confirmed, having during the past season had an opportunity of closely examining a number of *recent* specimens, of six of which the bones and other parts necessary to found the specific characters, are now in my possession. These added to six I had before, include with one exception, every preparation of the internal structure now in this city. Finding in every case, the same marked difference from every description of all other swans, I have considered it would be a sufficient warrant to separate this bird from those already indicated, and give it the title of *Americanus*.

Every writer on this bird, has heretofore considered the American swan, as identical with the European, and even Mr. Charles L. Bonaparte, a naturalist certainly of a very eminent order, in his synopsis of the birds of the United States, gives it as the Anas *cygnus*, Linn., Lath., etc. and the Cygnus *musicus*, Bechst. His generic description need not be repeated, and his specific characters are so general, that they would include our own as well as the two European wild swans which are now acknowledged to be distinct. I will here give it. C. *musicus*, Bechst. White,—top of the head yellowish—bill black without protuberance—bare space round the eye, yellow.

Neither Wilson nor any other American naturalist has particularly described our swan, the reason of which I am ignorant. I will now refer to the Essay of Mr. Wm. Yarrell,* Linn. Trans. Lond. Vol. xvi.

* This gentleman has been long known to the scientific world, for his curious and interesting observations on the organs of voice in birds, and other branches of Natural Science.

pt. II. in which he divides the English wild swan into two species, and describes them both minutely, giving us an opportunity before wanted, of instituting a comparison between them, and our own.

The Hooper (Cygnus *ferus*) is five feet from the point of the bill to the end of the tail—seven feet ten inches between the tips of the wings, and weighs twenty four pounds. From the point of the beak to the edge of the forehead, four inches and three eighths, and from the same point to the occiput, seven inches and one fourth—the sides of the bill parallel—the bright yellow color at the base of the upper mandible extends along each outside edge even *beyond* the line of the nostrils—tail twenty feathers. It is the internal structure that marks so particularly the character of the Hooper. This peculiar arrangement has been long known to exist, but has never before been so carefully described as to enable naturalists to found species on its variations. The trachea or windpipe which is of equal diameter throughout, enters a cavity in the keel of the sternum or breastbone, formed by a separation of its plates, and passing back *nearly* to the posterior extremity of the keel, folds upon itself, *always* retaining the vertical position in its doubling, and returns out at the same orifice it entered the keel, and winding round the merry-thought (*os furcatorium*) takes the regular route to the lungs.

In the oldest Hooper, this cavity *never* extended in the slightest degree farther back than the keel, and the fold of the windpipe *never* left the *vertical* position at any age. The bone of divarication or larynx is compressed, and the membrane between it and the bronchial tubes is unprovided with an arrangement to protect it, as it is in his other species. The bronchial tubes are very long. The difference in the admeasurements between the Hooper and his second species C. *Bewickii*, will be given, when I mention our own swan. I will now point out the distinguishing marks of the Bewick.

The beak is black at the point, and orange-yellow at the base; this last color appears first on the sides of the upper mandible, and afterwards covers the *upper surface in front* of the forehead to the extent of three fourths of an inch, receding from thence by a convex line to the lower edge of the mandible at the gape—the irides orange-yellow—the beak narrow at the middle, and dilated towards the point.

"The trachea enters a cavity in the keel of the sternum as in the Hooper, and having traversed the whole length of the keel, the tube then gradually inclining upwards and outwards, passes into a cavity in the *body* of the sternum posterior to the keel, produced by the separation of the parallel horizontal plates of bone forming the broad, flattened, posterior portion of the breast-bone, and producing a convex protuberance on the inner surface.

"The tube also changing its position from vertical to horizontal, and reaching within half an inch of the posterior edge, is reflected back after making a considerable curve, till it once more reaches the keel, after traversing which, in a line immediately over the first portion of the tube, it passes out and reaches the lungs as in the Hooper. This was the state of developement in the most perfect bird.

"The degree next in order, differs in having the horizontal loop of the trachea confined to one side only of the cavity in the *body* of the sternum, both sides of which cavity, are at this time formed, but the loop of the tube is not yet sufficiently elongated to occupy the whole space.

"The third in order, being that of a still younger bird, possesses only the *vertical* insertion of the fold of the trachea, yet, even in this specimen, the cavity in the posterior portion of the sternum already exists to a considerable extent. The bronchiæ are very short, and the flexible, delicate membrane that intervenes between the bone of divarication and the bronchial rings, is quite elongated, and defended on each side by a distinct membrane attached to the whole edge of the bone of divarication, and posteriorly, to a slender semicircular bone on each side, by which it is supported. The muscles of voice pass down as in the Hooper, one on each side of the trachea, till the tube is about to enter the keel, they then quit that part of the tube and pass to the ascending portion that has just issued from the keel, which they follow, ultimately branching off a little short of the bone of divarication to be inserted on each side of the sternum.

"The stomach, a true gizzard, is one third less than that of the Hooper—the intestinal canal is uniform in calibre and coiled up in seven oblong folds with two cæca.

"As in the Hooper, the plumage is first grey, afterwards white tinged with rust color over the head and on the under surface of the belly, and ultimately pure white. The tail has but eighteen feathers."

I will now describe a mature specimen of the American swan, and afterwards give such variations as youth may produce.

From its size, and the toughness of the joints and flesh, and the perfect absence of every mark of juvenility, I have no doubt this bird possessed every perfection of developement. It will be observed, that the dimensions and characters of the specimen, preserve, in a great degree, a middle course between the English species.

	Hooper.		Bewick.		American.	
Weight,	24 lbs.		13¾ lbs.		21 lbs.	
	Ft.	In.	Ft.	In.	Ft.	In.
Point of the beak to the end of the tail,	5	0	3	9	4	6
" " edge of forehead,		4⅜		3½		4⅛
" " eye,		5¼		4⅜		5
" " occiput,		7¼		6¼		7¼
Width of the beak at the widest part near the point,		-		-		1½
" " middle,		-		-		1⅜
" with wings extended,	7	10	6	1	7	2
Carpus to end of primaries,	2	1½	1	8½	1	11
Length of middle toe,		6½		5¼		6
" intestines,	12	0	10	2	10	7
" cæca,		11		10		10½
" breast-bone,		8½		6⅜		7½
Depth of insertion of the trachea,		3		5¾		6½
Length of bronchial tubes,		3½		1½		1¼
Tail feathers in number,	20		18		20	

The youngest and smallest specimen I have met with, and the bones of which I now possess, had a very soft, reddish-white bill, with a brown point, and measured three inches from the point of the beak to the forehead,—six inches and one eighth to the occiput, and the usual position of the colored spot was covered to one inch and three eighths in front of the eye, with small yellow-orange feathers, which extended down to the gape. The plumage, to the end of the tail and primaries, was of a deep leaden tint, and the feet and legs were of a light grey color. This specimen measured six feet and eight inches between the points of the extended wings—four feet two inches from the point of the beak to the tail, and weighed eleven pounds. In the specimen above, whose dimensions I have compared immediately with those of Mr. Yarrell, the yellow spot on the bill was five eighths of an inch in length, starting at the front corner of the eye and running towards the nostrils, and one fourth of an inch in breadth. In twenty specimens I have now examined of the American swan, I have *never* seen this spot more than one inch in length, and half an inch in breadth, and in many of them, an oblong mark of the size and shape of a little finger nail was alone found. In one instance, which weighed sixteen pounds, this spot was but one fourth of an inch square, and did not quite reach the eye. As the color and extent of this spot, is assumed by Mr. Yarrell, as one of the principal external specific differences between his two English swans, I have taken particular care to ascertain, beyond a doubt, the tint in the American bird, and find it ranges from a pure gamboge yellow to a bright red-orange, and without any regard to sex or age, except in the yearling, as above mentioned, when it is covered by small feathers. This mark is always in the same position. The feathers continue, except at the anterior fourth where the yellow spot reaches them, to the very edges of the eyelids, which are yellow. In every case, the bill has been one eighth of an inch narrower at the middle than near the point, and in all young birds, where the plumage had become white, a dirty yellow tinge around the head and back of the neck, marked its immaturity.

In several instances, a well defined yellow or orange line ran from the point of the feathers, between the legs of the lower bill, forward, to their junction at the point, and sometimes ended in a large patch of the same color. In *every* case, the tail had twenty feathers, although in the younger ones, there were several of them still in the sheath.

The other external characters are common to the genus.

The internal arrangements are those, in a great degree, of the Bewick swan. The wind-pipe is uniform in calibre, and entering the keel, takes the circuit of the horizontal pouch in the posterior flattened portion of the bone, and returning out of the keel at the same orifice it entered, winds round the merry-thought and goes to the lungs. Plate II, fig. 1.

In the specimen whose admeasurement is given in detail, the loop of the trachea occupied a posterior cavity of two inches in transverse diameter, leaving in the hollow of the loop, one inch of vacant space, and projecting one third of an inch above the *inner* surface of the sternum, but showing no rise externally. In another preparation I possess, (Plate I, fig. 1.) from a bird of equal age, the sternum is seven inches and a half in a straight line drawn across the concavity of the inner surface, and the posterior chamber extends to the extreme back edge of the bone, the trachea penetrating the whole distance. In this case, the horizontal chamber is three inches and one fourth in transverse diameter, and spreads, on one side, three fourths of an inch beyond the edge of the breast-bone, and covering and resting on the ribs to that distance. The vacuity in the loop is two inches in diameter. A third instance gives a bone seven inches and a half long, with the trachea extending to the very posterior edge, and the chamber in the bone two inches and three fourths across, and covering the whole breadth of the sternum.

Another preparation (Plate I, fig. 2.) six inches and one half long, of a younger swan than either of the preceding, developed a rising on the internal surface of one inch in diameter, with the trachea entering but four inches and three fourths, and just assuming the horizontal position,—and the very young bird already mentioned, and which was no doubt a yearling cygnet, produced a sternum six inches and one half in length, with the trachea entering three inches and one half, and preserving a vertical fold, and showing merely a gentle swelling in the bone at the posterior termination of a cavity four inches deep. (Plate I, fig. 3.) In every instance, the trachea, upon approaching this horizontal apartment, takes to the right to sweep round the cavity. The two portions of the tube, although in contact in the keel, are separated anterior to it by a strong ligament, which stretches in a right line across from one limb of the merry-thought to the other, and extends from the outlet from the keel, to near the union of the os furcatorium with the clavico-scapular bones. Lateral ligaments also pass from the limbs of the merry-thought to these bones, and form a chamber for the pulmonic portion of the trachea to lie in. (Plate II, fig. 2.) The muscles of voice pass from one portion of the tube to the other, and are united to the sternum as in the English species.

The bone of divarication is placed perpendicular to the sternum, and is one inch and an eighth from top to bottom, and the sides are so compressed that they are nearly parallel. The space between this bone and the bronchial rings is half an inch, and is occupied by a membranous tube, outside of which, extends another membrane from the edge of this bone to a delicate semi-circular bone on each side, which protects the structure within. (Plate II, fig. 1.) This arrangement is nearly the same as in the Bewick.

Linnæus gives the wild swan as having but eleven ribs, and the tame, twelve,—while the article Swan in "Delineations of Zoological Gardens, London," states the wild to have twelve, and the tame swan but eleven ribs. Mr. Ord (than whom there cannot be better authority in ornithology,) assisted me in ascertaining the number of ribs in the dried specimens I possess, and we were unable to discover more than ten, the first of which did not reach the sternum, but was united to the second by a membranous connection.—A particular examination of these bones was unaccountably neglected whilst the birds were recent, and there may *possibly* be an error in the number of ribs. There were twenty six true vertebræ.

The gizzard of the specimen particularly described above, weighed five and a half ounces—and the intestines were in every case coiled

Fig. 3.

Fig. 2.

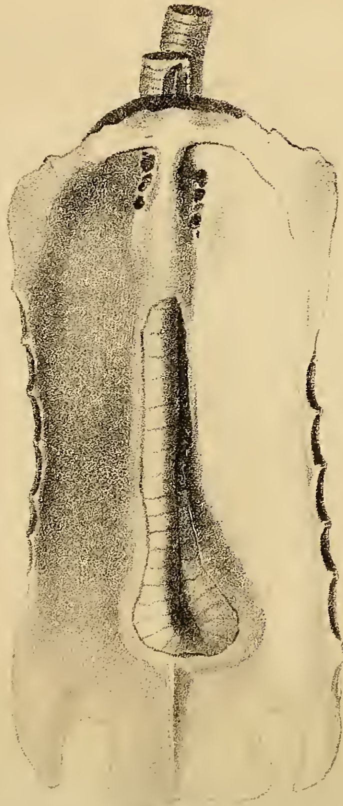
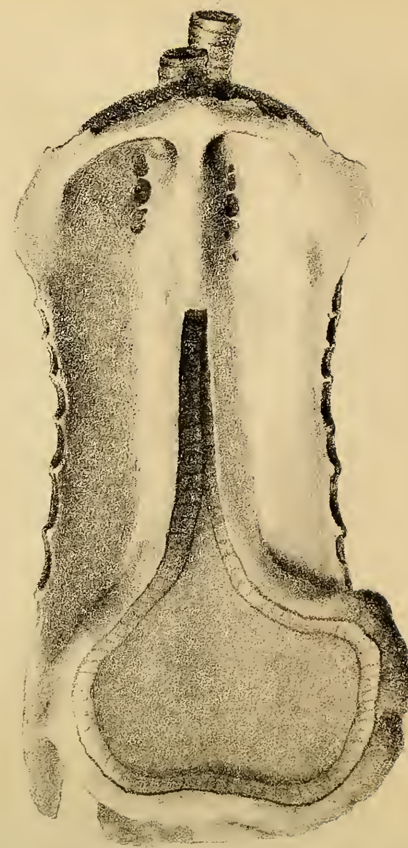


Fig. 1



M.E.D. Brown del.

PL. 1.

his Lith. No. 5 Library St. Phil.

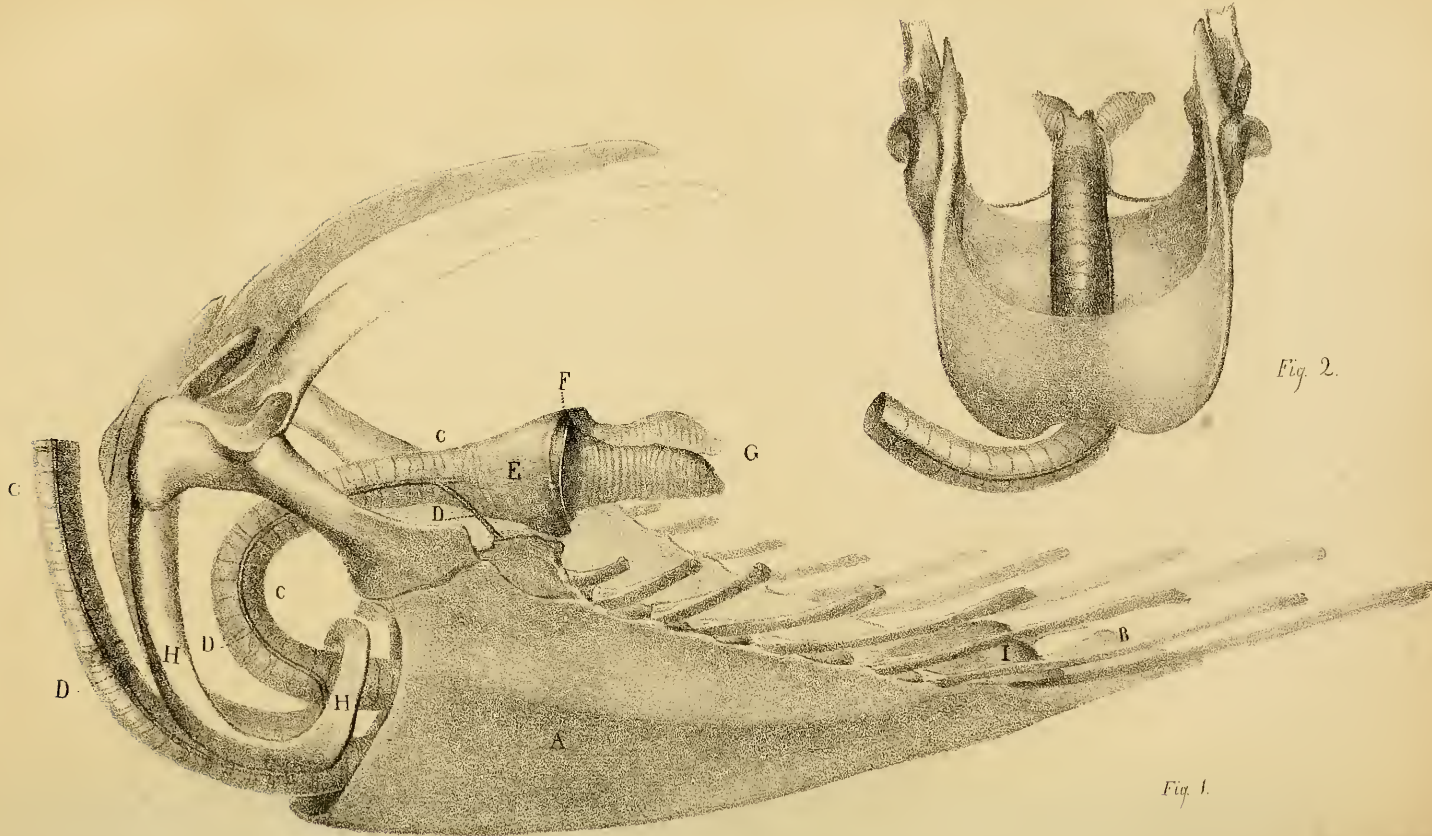


Fig. 1.

Fig. 2.

M. E. D. Brown del.t   Pl. 2.   his Lith.r 45 Library St. Phil.a

in seven oblong folds and had two cæca, which were often of different lengths.

I have not discovered any variety either in external appearance, or internal peculiarity to depend upon sex.

Mr. Yarrell gives the following, as the specific characters of both the English wild Swans.

C. *ferus.* Beak black and semi-cylindrical—*base* and *sides even beyond the nostrils* yellow—body white—tail with twenty feathers—feet black.

C. *Bewickii.* Beak black and semi-cylindrical—*base* orange—body white—tail eighteen feathers—feet black.

The following is the specific character of the American Swan.

C. *Americanus.* Beak black and semi-cylindrical—*sides of the base,* with a *small* orange or yellow spot—body white—tail twenty feathers—feet black.

Note.—After the above had been written, I received a communication from Mr. Yarrell, London, containing a proof sheet of Dr. Richardson's "Northern Zoology," a work not yet published. It contains the following description of an American Swan which he met with in his expedition with Franklin, and which he considers the regular Trumpeter Swan. It is decidedly different from the *Americanus* in the *entire absence* of colored mark on the bill, and in the number of tail feathers. It is probably the species mentioned by Lewis and Clark.

Cygnus *buccinator* (Richardson) Trumpeter Swan.

Color white—Head glossed above with chesnut—*Bill, cere,* and *legs* entirely black.—Tail twenty four feathers. The fold of the wind-pipe enters a protuberance on the interior aspect of the sternum at its upper part which is wanting in the C. *ferus* and *Bewickii;* in other respects the wind-pipe is distributed through the sternum nearly as in the latter of these species.

EXPLANATION OF PLATES.

The specimens from which the figures were drawn, resemble so much those pictured by Mr. Yarrell, and the delineation of that writer being so admirably adapted to display the structure, that his positions and general outlining have been chosen by the engraver, the detail being changed to suit the peculiarities of my specimens.

Plate I.—Fig 1. Internal surface of the breast-bone of an adult Swan, the cavity in the sternum extending to the posterior extremity of the bone, and lying on one side even over the ribs. Part of the bones are removed to show the trachea.

Fig. 2. Showing less developement, being from a younger bird.

Fig. 3. Sternum of a cygnet of the first year, giving a mere swelling on the internal surface of the bone.

Plate II.—Fig. 1. Side view of the sternum and trachea of the Swan. A. The keel. B. Flat posterior part of the bone. C. C. Trachea. D. D. Muscles of voice. E. Bone of divarication or larynx. F. The delicate semicircular bone with the outer membrane attached, to protect the inner tube leading to the bronchiæ. G. Bronchiæ. H. H. Os furcatorium. I. Posterior horizontal chamber.

Fig. 2. Front view of the same part, the anterior portion of the trachea turned aside to show the inner ascending part of it—the muscles of voice, and the tendinous membrane by which both are supported.

Art. V.—*On the analogy which exists between the Marl of New Jersey, &c. and the Chalk formation of Europe.*

Letter from S. G. Morton, M. D. to the Editor, dated Philadelphia, Feb. 14, 1832.

PROFESSOR SILLIMAN.

Dear Sir—Constant engagements, chiefly of a professional nature, have, for nearly two years past, prevented my taking an active part in geological inquiries; at the same time I can assure you, that my interest in the subject has in no degree diminished, which must be my apology if this communication should appear too long or too minute.

Since the publication, in your valuable Journal, of my "Synopsis of the Organic Remains of the Ferruginous Sand Formation of the U. S."*—I have waited with patience for the judgment of European geologists upon the opinions therein advanced; and have at length the gratification to observe, that those opinions have received the support and corroboration which I had little doubt would be awarded to them.

In a letter recently addressed to me by Prof. Alex. Brongniart, are contained the following observations; to which I shall subjoin an extract from the report alluded to by this eminent geologist.

"I have been struck with the analogy," says M. Brongniart, "which exists between the American beds, referred by you to the chalk series, and certain European deposits belonging to the same Pelagic group. I have communicated this curious fact to the Royal Academy of Sciences, in a *Report* lately submitted to that body in relation

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* Volumes XVII and XVIII.

to a similar group observed in the south of France, by M. Dufresnoy, Mining Engineer. This Report has been published in the XXII volume of the *Annales des Sciences Naturelles;* and I have therein mentioned your important observations, at the same time availing myself of them, to support the principles I some time since advanced in my work on the Importance of Zoological characters in Geology.

"You will perceive that I have not hesitated to admit, with M. Dufresnoy, that the formations he has described, belong to the *Cretaceous group,* although they contain some organic remains, characteristic of tertiary beds: (terrains thalassiques.) In like manner, while the deposits which you have referred to the chalk series, contain some fossils which occur also in other formations, we cannot for this reason refer them to any other than the chalk, because the characteristic reliquiæ of the latter predominate so much, as at once to determine the epoch to which they belong: for, excepting a few terebratulæ, &c., I can only recognize these fossils in *secondary* beds, and more specifically in those which I have designated by the name of *Pelagic.*

"The fossils you describe are not only *characteristic* of the cretaceous group, but are found neither abundantly nor constantly in any other: they belong to the entire extent of the series; nor am I certain that they are more indicative of the lower chalk (la glauconie crayeuse et la craie tufau) than of the upper or white chalk.

"With respect to amber (succinite, Br.) and lignite, they are rarely observed in the chalk mass, but are mostly found above it in the plastic clay, or *below it in the marls of the green or ferruginous sand:* but these substances are of too little importance to affect a position established by other characters."

M. Brongniart further explains his views of the chalk formation, in the Report on M. Dufresnoy's memoir, above alluded to, from which I shall beg leave to offer two or three extracts; merely premising that the Report is signed by Messrs. Beudant and Brongniart, but is from the pen of the last named gentleman.

Extracts from the Report on the Memoir of M. Dufresnoy, &c.—Read before the French Institute, April 25, 1831.

"Every one thinks he knows what *chalk* is: the inhabitants of Paris, and of the north of France, who are surrounded by chalk hills, who see this mineral employed for numerous domestic purposes, and in the arts, always figure to themselves a soft stone remarkable for its whiteness. Those who have seen it in the quarries, or noticed its vast masses not distinctly stratified, and separated by beds of black flint, suppose these features essential to its external characters."

* * * * *

"This idea, although tolerably correct, is not complete: for a long time its external and mineralogical characters were alone considered; while its geological features, or those which belong to the formations (terrains) it embraces have been almost entirely overlooked, as well by geologists as by naturalists in general.

"The difficulty does not consist in recognizing beds of white chalk containing black flint, but in detecting those deposits which want these external characters, and yet belong to the same age and formation. Now we determine a formation (that is to say, any combination of mineral substances which have been deposited at the same time,) by the position it occupies, relatively to the series which forms the crust of the globe; or in other words, by the kind of rocks or deposits which are constantly found above and below it: this is the *geological character*, or that of superposition, the most important of all when clearly ascertained.

"But in order to assign its proper place to any substance, it must be so well characterized as to be known even when entirely insulated. The nature of the rock and the accompanying minerals may avail us in this inquiry, whence they are termed *mineralogical characters:* they are the most obvious, but at the same time the least essential characters, and most likely to deceive; and they, in fact, prevented our recognizing the chalk, (or rather the *cretaceous formation*,) in those places so familiar to us long before the time of M. Dufresnoy.

"A third series of distinctive characters is derived from organic remains; these are called the *zoological* or *organic characters* of a formation.

"It will now be understood what we mean by a *chalk formation*, or rather by a *cretaceous formation:* we must not picture to ourselves deposits wholly composed of white chalk; but include in the designation all those beds which occupy, among earthy strata, the same position as the chalk, enclosing the same characteristic fossils, and sometimes also presenting the same assemblage of mineralogical characters. We shall find cretaceous formations both black and yellow, *en masse* or stratified, with or without silex: we shall even see that these deposits are sometimes composed entirely of sand, and of sandstone, without a particle of chalk, mineralogically speaking, or even of carbonate of lime."

* * * * *

"Among the formations recently admitted into the cretaceous group, one of the most remarkable occurs in America, and at so great a distance, that we might suppose it would be deficient in those specific characters, by which it could be referred to any one of the geological divisions: we allude to a formation described by Dr. Morton as occurring in New Jersey and Maryland.* Dr. M. has given an exact description of these beds, with figures of the fossils they contain. These descriptions and illustrations present a complete application of the principles we have endeavored to establish. The animals are those of the cretaceous deposits, viz. the genera baculites, belemnites, scaphites, ammonites, terebratula, gryphæa, plagiostoma, ananchytes, mosasaurus, plesiosaurus, with many others belonging to the testacea and to the family of crocodiles. All these genera are characteristic of the chalk, although the species are not precisely the same; the differences, sometimes very slight, show in the ancient world, what we notice in the existing state of things in places very remote from each other. Thus, North America possesses many of the same *genera* of animals as are found in Europe, and yet very few *identical species.* The American formations moreover embrace, like the chalk of the south of France, many littoral shells, [or shore-shells, to distinguish them from *Pelagic*, or such as inhabit deep water,] among which are naticæ, scalariæ, cyprææ, patellæ, &c.

"These characters convinced Dr. Morton, and they should satisfy all geologists, that the deposits of New Jersey and Maryland must be referred to the cretaceous series: but they moreover present many mineralogical characters of the chalk, such as glauconie, ferruginous sand, and silex. Finally, as if to render the inference still more precise, we find on examining its relative position, that this formation is in many places overlaid by true tertiary deposits, composed of clay, of sand, and of calcaire grossier, and containing fossil shells so similar to those of our Paris formations, that a very cautious examination is requisite to distinguish them."

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Such are the sentiments of M. Brongniart.—A letter just received from Mr. Mantell, enables me to record the opinion of a gentleman, whose many contributions to this department of geological science, place him among the most distinguished of its cultivators. I

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* It is now recognised in nearly all the States from New Jersey to Alabama.—Vide Jour. Acad. Nat. Sc. Vol. VI, and Am. Jour. of Science, *loco citato.*—S. G. M.

sent Mr. M. a small series of the organic remains of the marl district, &c. upon which he makes an interesting commentary, and then adds—"I have read your papers on the *green sand* of America, (in the Journal of Science) with great pleasure and interest; and I entirely agree in the opinion you express, that the strata in question, bear a decided analogy to the inferior division of the chalk formation of Europe. Your *limestone above green sand*, reminds me very much of the Maestricht beds. The latter appear to form, as it were, a connecting link between the chalk and the tertiary; for although in England, France and elsewhere, there is a marked separation between the *so called* secondary and tertiary formations, I believe it will ultimately be found, that this is not the natural order, but the exception; and that the transition from one to the other was gradual. In the Maestricht beds we have the ammonites, baculites, echini, &c. so characteristic of the chalk, associated with volutes, turritellæ, and other tertiary genera. So also I believe we shall find that even the tertiary formations run insensibly into the modern deposits."

I had some years ago, and indeed in my first* paper on this subject, mentioned some resemblances which appeared to me to exist between the Maestricht beds and the green sand of New Jersey; but Mr. Mantell's suggestion that such analogy obtains between the limestone *superimposed* on our marls, and the Maestricht deposits, is new to me, and seems to be founded in fact. The limestone in question, is apparently more recent than the green sand, and has hitherto afforded fewer pelagic, and more littoral fossils. It has been examined as you know, in numerous quarries between Salem and Vincentown, in New Jersey; (a distance of about forty miles) but has not yielded any multilocular univalve, unless the equivocal fossil which I have named *Belemnites ambiguus*, be of this character. Its characteristic relics, as I have elsewhere mentioned, are scalariæ, varieties of Gryphea convexa, and G. vomer, with numerous Linnean madrepores and echini. Is this a connecting link between our secondary and tertiary beds? My friend Mr. Nuttall has recently detected the green sand near Cahawba, in Alabama; establishing the known extent of this formation to a distance of about a thousand miles; for at Cahawba, the *Exogyra costata*, *Ostrea falcata*, and other species of shells, are specifically identical with those from New Jersey; nor indeed is there the shadow of a difference between them. Dr. Wm. Blanding has communicated some very interesting facts respecting

* Jour. Acad. Nat. Sciences, Vol. vi. p. 97.

the existence of this formation near Camden, South Carolina,* where it is chiefly recognized by exogyræ, &c. vast numbers of Belemnites (*B. americanus*, which, by the way, Mr. Mantell agrees with me in considering specifically different from *B. mucronatus*, of Europe.)

Much time, and the united labor of many geologists, will be requisite to make a complete exposition of this vast formation, which promises to the explorer a series of facts perhaps no less interesting than has been afforded by its equivalent in Europe.

Before concluding this letter, I have much pleasure in mentioning that our Atlantic tertiary deposits are in a fair way to be brought to light. Under the patronage of the Academy of Natural Sciences, those of Maryland and Virginia, have been repeatedly visited of late, by my friend Mr. T. A. Conrad; a young geologist whose discriminating judgment, and untiring industry, have already attracted the favorable notice of the scientific public. A work which this gentleman has now in hand, will make us acquainted with nearly two hundred species of fossil shells from the *upper*† *marine* deposits of the state above named; nor are these remains inferior in beauty and preservation to those of the tertiary beds of Europe. It is to be borne in mind that this multitudinous series of organic relics, has been obtained in a comparatively circumscribed space; and that the vast tract from the north eastern section of Virginia, coastwise to the Mississippi, remains almost entirely unexplored. How greatly inquiries of this nature might be facilitated, if persons resident in places where the fossils occur, would collect and transmit them to our public institutions! The Academy of Natural Sciences is now in possession of all the species hitherto described; they are classed and labelled, and displayed in manner so conspicuous as to be consulted to the utmost advantage. Our European series, so important for comparison, is increasing rapidly; a part of it, designated as the *Wetherill collection* of British fossils, embraces about a thousand specimens from all the formations. The continental series is much less complete. The entire Geological series contains about five thousand specimens, of which more than two thirds are fossil organic remains of animals and plants—a good nucleus for an institution which has been but twenty years in existence.

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* I formerly mentioned Cockspur Island, Georgia, as a locality of green sand, but find that I was misinformed; this island is now known to be destitute of fossil remains.

† Jour. Acad. Vol. VI, p. 116, &c., in which I have proved the deposits in question to belong to the upper marine formation.

Art. VI.—*Description of an instrument called the Steam Pyrometer;* by Walter R. Johnson, Professor of Mechanics and Natural Philosophy, in the Franklin Institute, Philadelphia.

A careful attention to guard the containing vessel in which we produce steam from boiling water by means of metal, or other solid or liquid bodies capable of being heated in open vessels above 212° Fah. will enable us to measure with great accuracy, the quantity of heat which such solid or liquid body expends in cooling, from the temperature at which it is first put in, down to the boiling point of water.

The mode of calculating the temperature when the specific heat is known, has already been given.* The only points of much difficulty in rendering the formula heretofore stated, directly useful in pyrometry are, 1, the necessity of defending the vessel in which the steam is produced, from the effects of radiation and conduction during the operation; 2, the obviating of loss in transferring the hot body to the liquid through the air; 3, the means of obtaining and marking the true boiling point, and 4, the means of speedily and accurately weighing the liquid, and showing how much has been evaporated during an experiment.

To these causes of inconvenience, may be added, that which results from the low specific heats of some of the substances, to be employed as standards.—Such are several of the metals as platina, gold, &c. It is obvious that the method of plunging the body of which we would know the temperature directly into boiling water, can be adopted only with regard to solids, which remain unchanged after being quenched in water, and which are not capable of imbibing the fluid, on account of porousness, or such physical characters as would render them liable to combine chemically with the water.

When we have to deal with liquids of which the temperatures extend beyond that of boiling mercury, that is, of mercury boiling in vacuo, (which must necessarily limit our use of the mercurial thermometer,) we must either pour such liquid into the boiling water, if a melted metal which will not undergo change in that method of cooling, or must enclose it in a suitable vessel extremely thin and of materials to sustain the action of water upon it, or must immerse in the hot liquid or the melted metal, a mass of some other matter capable of preserving its form under a heat greater than that of the liquid. The latter method is

* See American Journal, Vol. XX. p. 316, July 1831.

STEAM PYROMETER BY W.R.Johnson.

Fig. 1.

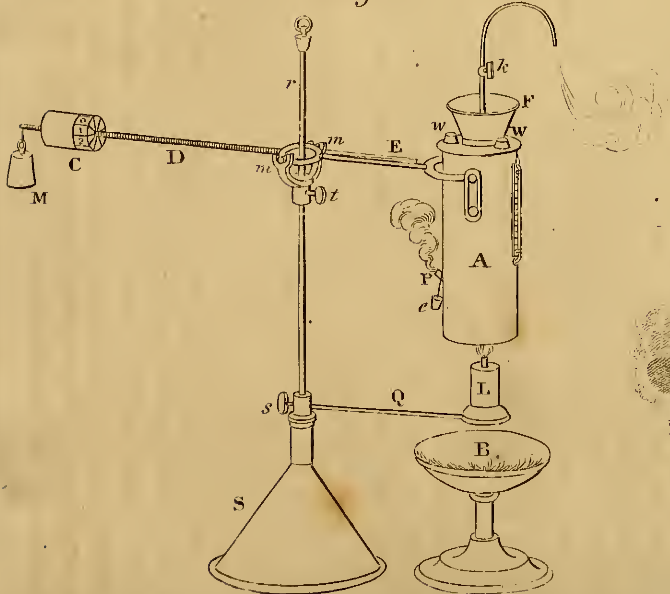

Fig. 2.

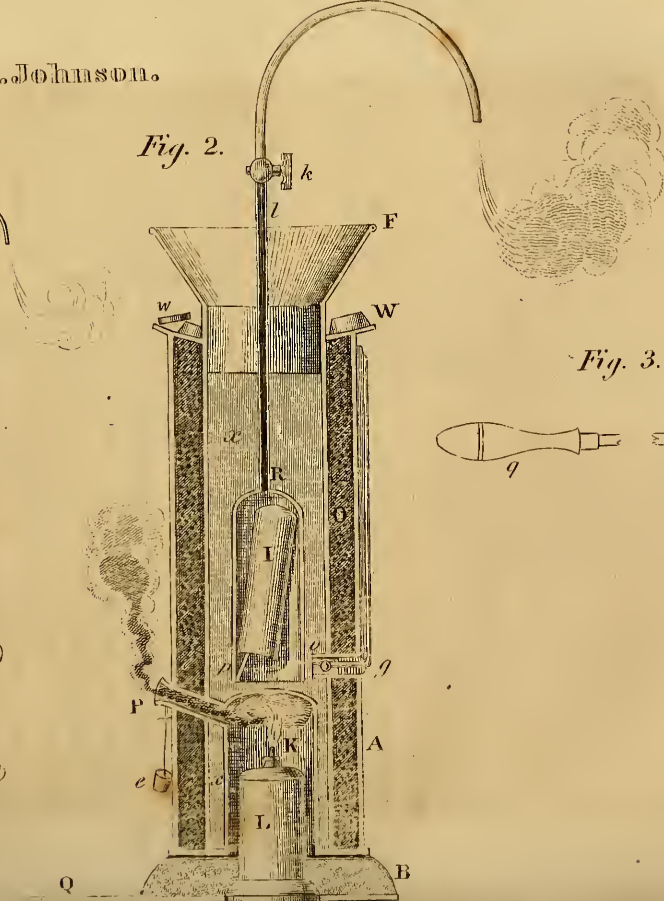

Fig. 3.

on several accounts to be preferred. First we may always use the same amount of hot matter to produce the vapor, and consequently compare the actual heats of two melted masses without calculation. Second, the hot body may be directly applied to the water without the intervention of any enclosing vessel. Third, the pouring of the hot metal or liquid into water might not always be convenient or safe, as for example when the latter is of greater specific gravity than the former. When, for example, oil is laid at a very high temperature, on the surface of water, the sudden ebullition of the water, would be in danger of causing an explosion that would project the oil upwards with great force.

When we plunge a solid into a melting mass of metal, and allow it to remain for some time, it will acquire the temperature of the mass of melted matter, but the *solid* must have certain peculiar properties to fit it for this purpose.

First, it must not melt at a lower point than that of the fluid which it is intended to test.

Second, it must allow of being quenched in boiling water from the highest temperatures employed, without cracking, scaling, oxidizing, or undergoing any augmentation of weight by absorbing the liquid.

Third, it must have as high a *specific heat* as practicable.

Fourth, it should be capable of being easily wrought into the peculiar form required for the instrument with which it is to be used.

Among the substances best adapted for the purpose are the following, against each of which the specific heat is marked together with the name of the author, whose determination has been followed.

	Spe. Heat.	Authorities,
Crown glass,	.2000	Irvine,
White glass,	.1870	Wilcke. (.1770, Pet. and Dul.)
White clay, burnt,	.1850	Gadolin.
Black lead or plumbago,	.1830	Do.
White cast iron,	.1320	Do.
Soft bar iron, sp. gr. 7.724,	.1190	Do.
Platinum,	.0314	Petit and Dulong.

The chief parts of this instrument are a boiler, A; (Fig. 1.)—a stand, S;—a balance beam, D, for weighing the boiler and its contents;—a lamp, L, to heat the water and to maintain ebullition between experiments;—a receiver, R, (Figs. 2 and 3.) and a cylinder of metal, I, to be employed as a *standard*.

The boiler is formed of two concentric cylinders of copper. The inner cylinder is two and a half inches in diameter, the exterior one is four inches, leaving a space of three fourths of an inch to be filled with finely powdered charcoal or lampblack, seen at O, in the section (Fig. 2.)

The *interior* cylinder rises half an inch above the exterior, which is twelve inches high. The former is then expanded into a funnel-shaped mouth, F, five inches in diameter at top, and two inches perpendicular height, intended to receive and return any portions of water which might be thrown up by ebullition, but not converted into steam. From the lower part of the apparatus a third concentric cylinder, K, rises about three inches and one fourth, where it terminates in a conical head furnished with a pipe, P, passing obliquely upwards through the two cylinders before mentioned, and firmly soldered to both. The purpose of this third cylinder is to receive the lamp L, and to expose a large surface to the action of its flame. *e* is a stopper intended to close the pipe, P, when the lamp is withdrawn and the experiment in progress. E is an index attached to the support *m*, in such a manner that the point E, may be elevated or depressed a few degrees, to correspond to the position of the beam D, and save the adjustment by weights *before* an experiment. The cylinder of lead C, is movable along the rod by means of a screw thread, cut the whole length of that arm. This mode of adjustment admits of the greatest accuracy, and is liable to less delay than the sliding weight. By means of the tightening screw *t*, the support *m m*, may be placed at any convenient height on the rod *r*, and by means of *s*, the lamp L, may be loosened and caused to revolve horizontally when the metal is about to be immersed; in which case the boiler will be for the time depressed, and will rest on the cushion B, which is composed of hare's fur, covered with soft flannel to defend the bottom from the access of air; the stopper *e*, is a further safeguard against the same source of loss. A thermometer *g*, bent at right angles, passes through the two concentric cylinders, having the bulb directly exposed to the water within, but defended from injury by a projection of its tube *o*, a short distance beyond the inner cylinder.

The receiver R, is about four inches in height, and one and a quarter in interior diameter, furnished above with a tube *l*, and a stop cock *k*, to convey away the steam, and to carry it, when required, into a vessel of cold water. The only direct access of the water *x*, to the hot body I, when in place, is through the *bottom* of the receiver. If the stop cock be closed the steam will soon fill all the surrounding space and keep the water down quite to the lower edge, but if the cock be opened, the steam finding an outlet will rise, and the water will follow and again produce a large quantity of vapor. It will generally be found expedient to allow a moderate discharge only at the mouth of the pipe, and to cause the greater part of the action to take place through the metal of the receiver R. The only uses indeed of this part of the apparatus are 1st, to receive, without loss of heat, the standard piece I, and deposit it in the water without coming in contact with the exterior air, and 2d, to prevent the dispersion of the water by the extreme rapidity of its action, particularly towards the close of the operation. The pipe of R, is wrapped with flannel.

The manner of transferring the standard-piece is seen in Fig. 3, where G is a cylindrical or slightly conical recipient either entirely closed, or having a few orifices *h*, *h*, *h*, at the bottom. This recipient is to be formed either of iron, copper, silver, platina, plumbago, wedgewood ware, or crucible clay, according to the heat to which it is to be exposed, or the materials into which it is to be plunged. It will often be found expedient to protect the cylinder I, from the direct action of the fused metal, of which we would ascertain the temperature, otherwise there might be an adhesion of some portions of the melted mass which would vitiate the experiment. When the body I, has been heated to the requisite degree, and is to be transferred to the receiver R, the container G, is laid, by means of the handle, *q*, *u*, on some convenient support; R is then inserted at the mouth so that the hook *p*, shall be on the same side with the handle; G and R are then inclined so that I may slide from the bottom of G into R, the latter is then rolled over upon the side *p*, when the concave base of I, will be received upon the hook, and the cylinder will take the position indicated by the dotted figure, the moment R is raised to a vertical position.

It may then be plunged in an instant into the boiling water, as seen in Fig. 2. The quantity of vapor produced, is shown by the weights W, *w*, which it may be necessary to add to A in order to restore the position of the beam, so that the index E, shall again point to an engraved line on the side of the bar.

The receiver R, may be kept in the water when not required for immediate use, and be weighed with the liquid both before and after the experiment. By this means its temperature will be the same as that of the water, and no calculation necessary.

The lamp L, instead of being removed by revolving to allow the generator A, to rest on the cushion B, may rise through the center of that cushion, which may, in turn, be supported by the rod attached at *s*. This arrangement is seen at B, Fig. 2, where the rod Q, sustains a small circular platform and cushion, as well as the lamp L.

The advantage of this arrangement is the saving of time, and the only inconvenience, that the lamp must be relighted after each experiment, as it will be extinguished by closing P and preventing the access of air from below to K. It must obviously not be kept burning under the generator during the experiment.

Instead of employing weights as at W, *w*, to reproduce the counterpoise, or show the equivalent weight of steam produced, I have graduated one *end* or *base* of the counterpoise C, by radiant lines, and caused to be removed a segment of about 60° along the screw D, through its whole length, so as to present a vertical plane surface, on which to form a scale; the graduations of this scale are, of course, regulated by the distance apart of the threads of the screw; the weight of the counterpoise is such that one revolution on the thread produces a difference of one hundredth of a pound at the boiler end of the beam. The periphery of C is then graduated into one hundred equal divisions, (indicated by the figures 0, 1, 2, 3, &c.) so that, as a complete revolution of the counterpoise, towards the end of the rod, marks an increase of one hundredth of a pound in the weight of water put into A, so a corresponding movement in the reverse direction, compensates for the same amount of loss by evaporation; and a movement through one of the *centigrade* divisions only, or one hundredth of a revolution, as marked on the end of the cylinder, of course indicates one hundredth of the above amount, namely one ten thousandth of a pound. If greater exactness were required, it might be obtained either by making the threads at a less distance apart, or by diminishing the counterpoise C, and substituting for a part of its weight a fixed weight M.

I have found the apparatus sensible to the fourteen thousandth of a pound or half of a grain, when fully charged for use, that is, when the boiler contained at least sixteen ounces of water.

The arrangement above indicated may be varied to suit the different purposes to which the instrument may be applied, and the standards will be different according to the temperatures to which they must be exposed. If the substance, of which the temperature is to be ascertained, can with safety be plunged beneath the surface of boiling water, without causing either chemical change or variation of specific gravity, this direct action of the substance is doubtless to be preferred to the intervention of any second substance as a standard. The quantity, or number of *therms** of heat present, in a given weight of the substance in question, will then be known, and if we know or

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* See Ch. Dupin. Méchanique, tome 3. p. 353, et seqq.

can determine the specific heat, we may calculate the temperature as already indicated. I have, in this manner, proved the quantity of heat present in melted iron. Practical men may, possibly, from occasionally experiencing the tremendous effect of generating a quantity of steam from the moisture of their moulds, imagine that the experiment of pouring melted iron into a vessel of boiling water will be attended with danger. But I can assure them, from repeated trials, that it is perfectly safe. Plunge into a bucket of water, a common small iron kettle, supported on feet: pour into this, when completely immersed, any convenient quantity of melted iron; the ebullition from the surface of the melted mass will be at first very slow or scarcely perceptible, while from the outside of the kettle it will be very vigorous. The whole will subsequently exhibit the same effects as are perceived when a piece of cast iron is immersed at a bright red heat.

The following experiment was made in August, 1831. Twelve ounces of melted iron were poured into about six pounds of water, at 212°: the result was eight ounces of steam produced. In order to calculate this case, and obtain the actual *power present in the state of heat* at the time of the immersion, we have to multiply the weight of steam by its latent heat, say 990°, which gives 7920°; this divided by the weight of metal, (twelve ounces,) gives 660 for the number of ounces of water, which one ounce of the metal would have heated one degree, in cooling itself down to 212°. But as the *temperature* of the metal is the thing required, we must divide the above by the specific heat of cast iron, say $\frac{1}{8.25}$ or .1212, which gives $660 \div .1212 = 5445°$. But it will be recollected, that a portion of this must be regarded as the *latent heat of melted iron.*

In order to show what the latent heat of cast iron *is*, we may adopt the plan of taking from a mass of melting iron, a lump not actually liquefied, quench it, and observe the weight of steam produced. Again, pour from the same mass a portion of the liquefied metal, and ascertain how much *more* steam, for the same weight, is given by the latter than by the former. The same proceeding may be adopted for all other metals and their alloys.

The following experiments and calculations will show the mode of applying the steam pyrometer.

1. A cylinder of cast iron, weighing 5668 grs., was heated to redness. It was then placed within the receiver and instantly plunged into boiling water, previously accurately weighed; after the entire cessation of ebullition, it was withdrawn and the deficiency supplied

by weights. The heat had been a moderately red heat;—now, as cast iron has a specific heat of about .1212, this multiplied by 5668 will give the equivalent weight of water =687, which heated to the same degree might produce the same effect. In the case just stated, the quantity of water found to have been evaporated was 674. Hence 674 multiplied by the latent heat in steam, (=990° Fahr.) gives 667260° = the grains of water which would be heated one degree by condensing the steam now generated. But as the iron was equivalent to only 687 grains of water, it must have been heated as many degrees above 212°, as 687 is contained times in 667260°, which is 971.2 times; hence this number added to 212° will give the temperature of the iron, expressed in degrees of Fahrenheit's scale, equal to 1183.2.

2. Another experiment, conducted in the same manner, and with the same cylinder, but at a cherry red heat, gave 945 grains of steam. By applying to this case the principle of the formula, as before, we have, as above, 5668 × .1212 = 687, for the equivalent of the iron in weight of water; and 945 × 990 = 935550 = the grains of water which would be heated one degree by the condensation of the steam produced. Then 935550 ÷ 687 = 1362 = the number of degrees which the iron must have lost in producing this effect, while it came down from its initial temperature of redness to 212°. To this again we add 212°, and obtain 1574° for the actual temperature.

3. A ball of cast iron, weighing 1665 grs., was heated to a bright red, and gave 230.2 grains of steam. Here 1665 × .1212 = 201.8 = the equivalent weight of water, which, if heated to the same temperature, would have produced the same effect, viz. 230.2 × 990 = 227898. Now this divided by 201.8 gives 1128 = the degrees above boiling point, at which the temperature was at first, or 1128 + 212 is equal to the actual temperature abore the zero of F., viz. 1340°.

4. With the same ball, a second experiment gave 139 grains of steam. Hence 990 × 139 = 137610, and this divided by 201.8 = 681.8, and to this add 212 and we have 893.8 for the temperature at first.

5. The next experiment was with a cylinder of wrought iron, weighing 6110 grains, having a specific heat of .1100, and consequently being equivalent to 6110 × .11 = 672 grains of water. The observed heat was a moderate red, and the loss in weight of water 780 grains, whence the temperature must have been (780 × 990) ÷ 672 = 1149 + 212 = 1361° Fah.

6. The same cylinder was again employed, and raised to a bright red, so as to "scale" on exposure to the air. It then gave 989.6

grains of vapor; consequently its heat must have been $\frac{989.6 \times 990}{672}$ $=1462^{\circ}$ above the boiling point, or 1674° of Fahrenheit's scale.

The process of calculation may be much simplified, when the specific heat of the *standard piece* has been accurately ascertained and its equivalent of water found; for we have then only to multiply the weight of steam produced by its latent heat, or heat of elasticity, and divide by that equivalent. This is the same as multiplying the *weight of steam* by a known constant fraction. In the fifth experiment above cited, the equivalent of the metal is 672 grains of water, so that the constant fraction by which to multiply the weight of steam actually generated, in any given experiment with that cylinder of iron, in order to obtain the temperature above 212°, is $\frac{990}{672}=\frac{165}{112}$, or (in decimals) 1.4732. This number, multiplied by 780, gives the degrees 1149, as before. The process may be farther abridged, by performing the multiplication by logarithms, in which case we should have the logarithm of 1.4732 constant, and hence it would only be necessary to find in the table the logarithm of the grains of steam, add it to said constant quantity, and find the *number* standing against their *sum*, for the temperature above 212°.

Thus, the logarithm of 1.4732 is	.168259
To which add the logarithm of 780 =	2.892095
And we obtain the logarithm of 1149° =	3.060354

It will be no less easy to solve the same problem by means of a Gunter's scale and a pair of compasses. The distance from 1 to the constant fraction, (1.4732 in the above case,) on the *line of numbers*, will reach from the number of grains of steam to the temperature, in degrees Fahr., above 212°.

We might, instead of determining the specific heat of the *standard mass*, by the ordinary methods, first heat it to a known temperature in boiling mercury, in oil, spirits of turpentine, melting zinc, lead, bismuth, tin, or any convenient alloy* of these metals, and then ob-

* The alloys of tin and lead are very convenient for this purpose. Their melting points as determined by M. Kupffer, (See Ann. de Chim. et de Phys. XL. 302; and Thomson on Heat and Electricity, p. 174.) are as follows:

Tin	*Alloy of*	Lead	Point of fusion.
1 atom	+	1 atom	466°
2 "	+	1 "	385
3 "	+	1 "	367
4 "	+	1 "	372
5 "	+	1 "	381

The alloy commonly employed by tin plate workers is I believe composed of 1 tin, +2 lead. The mean of several trials with that alloy have convinced me that its melting point is 385°.

serve the quantity of steam it produces in cooling down to 212°. The actual temperature of the liquid being known by observation, and the quantity of steam by weight, every other quantity of vapor given by different temperatures of the same standard mass, will be produced by a proportionate quantity of heat. It will be seen that this method of proceeding takes no account of differences in specific heat at *different temperatures*. It comes at once to a simple expression of the heating power of a body measured by a *single effect* of the heating principle, that of conferring the elastic form on water, already raised to the boiling point.

It will readily be conceived that the question of specific heats, of expansion, and contraction, and of course the variable rates of expansion at different temperatures might be wholly disregarded, if we had an invariable standard by which to measure the portions of heat, that may at any time be present in a given portion of matter. The latent heat of vapor supplies this standard. The following are some of the different results which have been obtained by those who have made experiments on this subject.

Latent heat in vapor.	Determined by
950°	Watt.
945	Southern.
1000	Lavoisier and Laplace.
1040.8	Rumford.
955.8	Despretz.
above 1000	Thomson.
1000	Ure, (corrected result.)
mean 984	

I have in the preceding calculations assumed the latent heat, at 990°. Should the results of Dr. Ure, which appear to have been made in a manner as unexceptionable as any yet published, be confirmed and established by other philosophers, the facility of making calculations such as I have above presented, will be increased and the usefulness of the principle in pyrometry more fully established.

NOTE.—The experiment on melted iron, on page 101, is offered *chiefly* as an *illustration*. The apparatus then at hand did not admit of all the exactness which the case allows;—still the result is believed to be nearly correct.

Art. VII.—*On pure Chloric Ether; by* Samuel Guthrie;—*in a letter to the Editor, dated Sacket's Harbor, Feb.* 15, 1832.

Dear Sir—In some one of my letters to you, I think I advanced the opinion that chloric ether, like some other ethers, decreases in specific gravity as it increases in strength;—that opinion was erroneous, and my object in my last was to correct it.

I am now able to answer the query at the end of the last number of the American Journal of Science and Arts, and I do it in the affirmative.*

Chloric ether may be entirely, or very nearly so, separated from alcohol by repeated rectification, from muriate of lime; it may thus be brought to the specific gravity of 1.44, but I have found no agent for that purpose comparable with strong sulphuric acid. Chloric ether, distilled off sulphuric acid, has a specific gravity of 1.486, or a little greater, and may then be regarded as free from alcohol; and if a little sulphuric acid, which sometimes contaminates it, be removed by washing it with a strong solution of carbonate of potassa, it may then be regarded as *absolutely pure*. In this state it boils at 166°, has a specific gravity of 1.486, at 60° is extremely volatile, diffuses upon the tongue and fauces, a powerful ethereal odor, and excites, to an intense degree, its peculiar scent and aromatic taste. Admitting its composition to be 1 proportion of chlorine =36 +1 proportion olefiant gas =14, it contains nearly 346 times its own bulk of chlorine.

Sulphuric acid affords a fine test of the presence or absence of alcohol; if alcohol be present, so soon as the chloric ether is all over, the acid acts upon the alcohol which it has detained, and generates sulphuric ether, which is instantly indicated by its peculiar flavor:—if no alcohol be present, *no* sulphuric ether will be produced. Again, if there be alcohol present, the acid unites with it, is diffused through, and blackens the whole mass; but if otherwise, the ether lies clear and transparent upon the surface of the acid, until it is entirely distilled off.

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* "Can any method be devised by which the alcohol can be detached from the chloric ether, and the latter obtained concentrated and in quantity?"—Am. Jour. Vol. XX, p. 408.

Caustic potash in strong solution, even at boiling point, has no action upon pure chloric ether; but if the ether be considerably diluted with alcohol, it decomposes it, and forms a profusion of muriate of potassa.

In my apparatus for preparing chloric ether, I have taken advantage of the different temperatures at which alcohol and ether boil. The vapor which arises during the distillation, and which contains both alcohol and ether, is made to traverse a worm immersed in water heated to 170°. At the point where the worm issues from the hot water, a branch worm, with a modification of Welter's tube, is attached to its under side, when both worms are conducted into and through a vessel of cold water, issuing from it at a distance from each other convenient for placing under them proper receivers. As alcohol boils at 176°, of course it must condense at 170°, and will be condensed in the main worm above the branch, and be discharged at its outlet, whilst the ether, which boils at 166°, cannot be condensed at 170°, and therefore passes around from the insertion of the branch, to be condensed in the cold water, the whole affording me, whilst the ether lasts, two separate streams, one of ether and the other of alcohol. This little addition to the common distilling apparatus, diminishes very greatly the trouble of making chloric ether.

As chloric ether is said to have a specific gravity of only 1.22 at 45°, a boiling point at 152°, and to be decomposed by sulphuric acid, evolving chlorine, you may have good reason to doubt the purity of my product, or the accuracy of my estimate, but you can very readily verify the first, and I shall be found to be very near the truth with the latter. I regret my inability to forward to you immediately a beautiful sample of *pure chloric ether* which I have prepared for that purpose, and which I shall send as early as possible.

Art. VIII.—*Steam Boats protected from the Effects of Lightning;* by Alexander Jones, M. D.

PROFESSOR SILLIMAN.

Athens, Geo. January 5, 1832.

Sir—Having seen it stated, that there had been no instance known of a steam boat's being struck with lightning, while under way, since their use in the United States, I was led to reflect on the cause of their exemption, if such was the fact. It was likewise hinted in the above statement, that there might be something about a steam boat that acted as a non-conductor.

In order to ascertain how far the evolution of steam influenced the free passage of electricity, I constructed a small steam boiler, with two stop cocks placed at the distance of two or three inches apart on the top of the boiler. Just above, and on one side of one of the stop cocks, I placed a small brass ball, supported in its position by a stiff wire attached to the boiler. On filling the boiler half full of water, and placing it in a hot furnace, steam pretty highly condensed was made to escape through the cock, near the mouth of which was placed the brass ball. On charging a large Leyden jar until it emitted a spark of electricity, the size of a broom straw, and connecting the top of the jar by a small brass chain, which was fastened at its opposite end to another brass ball; this ball being held by the point of a rod, screwed into it, having a glass handle, and which was made to approach the one fixed to the boiler till they nearly touched, having a small stream of steam issuing between them; I found no electric spark whatever could be made to pass from one ball to the other however near they were approached, while steam continued to issue between them. Yet if the jar was discharged in any other direction than by the balls and through the steam, the spark, or shock would be almost sufficiently large to kill small animals, or to produce severe effects on a man. I found, on repeating the experiment, that it utterly failed to give a spark through steam in any direction. That it could not be made to strike at any distance within the influence of steam. Neither could it be made to strike the hot boiler. Nor could it be made to strike a red hot ball of iron; but as the ball cooled some, it would receive small sparks. A smooth polished metallic surface would also conduct it off without much noise. From the above experiments it may be concluded that steam is a powerful and ready conductor of electricity, so much so, that a small stream of it can instantly discharge a large Leyden jar, which is heavily charged, and that without the least apparent spark or noise.

It is therefore pretty well proved, that the *steam generated in a steam boat completely protects it from the effects of lightning*. The electricity of the clouds, that would otherwise in many instances strike steam boats loaded with so much iron; on coming in contact with the moist and heated column of steam, which ascends above the boats, immediately diffuses itself through the volume of steam, and passes to the water without communicating any shock. Or in other words, the ascending steam performs the office of a Franklin rod. The steam being in such a case a much better conductor, than the iron of the boat, the electricity will always take the steam in preference to striking any part of the boat; and this it will do in so diffused a manner, as never to be perceived or felt. If a boat is ever struck, we presume it will occur while she is lying cool at the wharf, and beyond the influence of higher objects; but in no instance probably will it ever happen while she is discharging steam. Houses could be protected in a similar manner, provided a steam tube should be made to pass from a boiler at the ground, to the top of the chimney; but as Franklin rods are equally good protectors, and much cheaper, they are to be preferred.

Remarks.—It will be remembered that, some years since, probably as many as ten, (for I have no document at hand to refer to, for particulars) the boiler of a steam boat, I believe in motion, exploded in the harbor of Charleston, South Carolina, in consequence of a stroke of lightning. The boat was under the general superintendance of the late Mr. Samuel Howard,* of Savannah, who was on board; and in a conversation with me on the subject, he attributed the explosion to the sudden expansion of the steam by the lightning.

Perhaps this fact does not militate against the views of Dr. Jones, for there may be discharges of atmospherical electricity too powerful to be quietly disposed of by any artificial conductor; that is, the amount of the electric fluid may be greater in a given case, than steam or metal can transmit without accumulation of heat, and without violence. The heat produced by electric discharges, although transient, is often very great, and if in the case above referred to, the mere expansion of the steam by the lightning, should not be supposed sufficient to account for the effect, is it not possible that there might have been a great addition to the quantity of steam, by the electric heat transmitted through the metal of the boiler to the water, and through the water itself, which is an imperfect conductor?

There can be no doubt that a steam boat is less liable to be torn by lightning, than a vessel of the common construction; for, not to mention the steam, her iron chimney and working piston, and in short all the masses of iron present a large conducting surface for the lightning, and the connexion is finished by actual contact of the metal with the great flood of waters beneath. A steam boat is somewhat in the condition that a ship would be, whose masts were all of iron,

* A man of an acute and philosophical mind.

and reached down to the water. We should think that such a ship was nearly secure from being torn by lightning. It is obvious that the popular apprehension as to the peculiar danger which, on account of their large amount of metallic matter, steam boats are supposed to incur in thunder storms, is groundless, and excepting the very extraordinary case of the boat in Charleston harbor,* we do not know another fact that countenances the common impression.—Ed.

Art. IX.—*Abstract of Meteorological Observations, taken at Marietta, Ohio;* by S. P. Hilrdeth, in the year 1831.—Latitude 39° 25′ North. Longitude 4° 28′ West of Washington.

Time of observation, at sun-rise, and at 2 and 9 o'clock, P. M.

MONTHS.	Thermometer.				Warmest days.	Coldest days.	Fair days.	Cloudy days.	Rain		PREVAILING WINDS.
	Mean temperature.	Maximum.	Minimum.	Range.					Inches.	Hundredths.	
January,	26°	62°	00°	62°	4	13,27	12	29	4	04	N.N.W and W.
February,	31	75	-2	77	28	6	21	7	2	50	W.N.W. and S.W.
March,	46	76	17	59	1	17	21	10	2	92	W.S.W. and E.S.E.
April,	54	86	24	62	18	12	22	8	2	85	W.S.W. and N.E. and E.
May,	61	89	30	59	31	10	17	14	4	25	W.S.W. and N.N.W.
June,	71	91	51	40	1	6	20	10	7	00	S.S.W. and N. and S.E.
July,	74	85	48	37	19,27	11	17	14	12	12	S.S.W. and N. and E.S.E.
August,	70	86	51	35	18	29	12	19	7	58	S.S.W. and N. and S.E.
September,	62.50	82	41	41	7,10	30	13	17	3	58	S.W. W. and N.W.
October,	54	82	26	56	23	29	20	11	3	70	S.W. W. and N. and S.E.
November,	40	70	12	58	8	29	15	15	1	25	W S.W. and N.W.
December,	21	42	-10	52	2	18	15	16	1	75	W.N.W. and S.W.
For the y'r.	50.87						205	160	53	54	

Mean temperature for the year 50.87, being four degrees less than in 1830.

Total amount of rain and melted snow 53.54 inches, or nearly four and a half feet.

205 fair and 160 cloudy days, being fifty-seven days, or nearly two months more cloudy weather than in the year 1830.

The mean temperature for the winter months is 26°.

Do. do. for the spring months is 53.66°.

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* The editor would be obliged by an exact account of that disaster, from some person acquainted with the facts.

The mean temperature for the summer months is 71.60°.
Do. do. for the autumnal months is 52.16°.

Difference in the mean temperature of the winter months in the year 1830 and the year 1831, is 7.66°, that of 1830 being 33.66°.

Depth of snow in 1831, forty-eight inches; the greatest fall at any one time being fifteen inches. Depth of snow in 1830, being thirteen inches. Depth of rain in 1830, being 37.26 inches. Difference in favor of the year 1831, 16.28 inches.

The past year has been marked with many singular features, and the extremes in moisture and temperature have been very great: the winter months attended with a degree of cold only found in the arctic regions, and the summer months with floods of rain peculiar to tropical climates. There seems to have been a belt of clouds encircling the western States for the last six months, opening at distant periods, and for such short spaces of time, to the rays of the sun, that solar heat, since the great eclipse in February last, has done but little in warming the surface of the earth. The spring months were cold, and fruit trees nearly twenty days later in blossoming than in the year 1830. Heavy rains commenced falling the last of June, and continued through the summer months, filling the rivers and creeks to overflowing, and deluging the low grounds with water. Crops of small grain and hay suffered greatly, being in many places on the borders of the streams entirely swept away, and in others beaten down and destroyed. Much of the wheat on the uplands, after it was reaped, vegetated in the shocks, and some while standing in the fields before it was cut. Hay suffered in the same way, and the produce of whole meadows was lost, or so much damaged as to be worthless and unfit for food, being altogether deprived of its saccharine and mucilaginous properties. Corn crops suffered less, and were very good where planted on lands not inundated with rain. Potatoes were better and more abundant than usual; which may be attributed to the coolness of the season, this climate being generally too hot in summer for their healthy growth. Apples, where they escaped the late spring frosts, were abundant and fine. Peaches were poor, being deprived of their aroma and sugar by the excessive rains; many of them rotting on the trees long before the season of ripening. Pears, being better suited to cold and wet, succeeded very well, and afforded fine crops. The productions of the garden were generally as good as they usually are in any season. Autumn wasmild and tolerably pleasant, but afforded us only eight or ten days of "Indian summer," in place of the three or four weeks with which we are commonly favored. The last of November, winter commenced with the rigor of the northern regions, and quite as unexpectedly to our farmers and boatmen, as the winter of 1812 to the armies of Napoleon ; nearly half the potatoe and corn crops being yet ungathered. By the fourth of December the rivers were full of ice, and steam-boats ceased running. By the tenth of the month the Ohio river was frozen over, and for the rest of the month could be crossed and traveled on by the heaviest teams, the ice being from twelve to eighteen inches in thickness. On the eighth of January, 1832, after a heavy rain and thaw, the river rose ten or fifteen feet, and the ice gave way, destroying a great many steam-boats, which lay along the shores in exposed situations, and hundreds of "Orleans" or flat boats. Some idea of the intensity of the cold may be formed, when it is known that the Mississippi river was frozen over one hundred and thirty miles below the mouth of the Ohio, a circumstance before unknown since the settlement of the western States. The river was loaded with floating ice below Natches, and the boys in New Orleans were surprised and delighted with the sight of water sufficiently frozen to afford them skaiting. The winter thus far has been one of great severity : the snow has not been more than six or eight inches deep, but the thermometer has been on several mornings from 5° to 10° below zero, and for whole days only a few degrees above.

February 3d, 1832.

Art. X.—*Further Experiments on the Disinfecting Powers of Increased Temperatures; by* William Henry, M. D. F. R. S. &c.

From the Philosophical Magazine and Annals for Jan. 1832.

In the Phil. Mag. and Annals, for November, I described a series of experiments, which established the following conclusions:—

I. That raw cotton, and various kinds of piece-goods, manufactured for clothing from that or other materials, sustain no injury whatsoever, either of color or texture, by exposure for several hours to a dry temperature of nearly 212° Fahrenheit.*

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* The temperature, I have since found, may in most cases be safely raised forty or fifty degrees higher.

II. That the infectious matter of cow-pock is rendered inert, by a temperature not below 140° Fahrenheit; from whence it was inferred that more active contagions are probably destructible, at temperatures not exceeding 212°. This proposition it was obviously within the reach of the experiment to determine. But I had intended to have resigned the inquiry, to those who are engaged in the practice of medicine, as more within their province than my own; when the appearance of malignant cholera at Sunderland determined me immediately to extend the investigation. If that disease be communicable from one person to another, there appeared ground for hope that any new facts or principles, respecting contagion generally, might be brought to bear upon this particular emergency. If cholera should be proved not to be so communicable, there still would remain many infectious maladies, to which any newly acquired knowledge of the laws of contagion might admit of beneficial application.

Of diseases generally allowed to be contagious, I could obtain access to two only, typhus and scarlatina. The former malady does not, however, answer to all those conditions which are required to render it a fit subject of experiment. It is less distinctly marked, than many other diseases, by characteristic appearances; and it is judged to exist, from a collection of symptoms, each of which is occasionally wanting, and each of which, when present, admits of such an infinite variety of shades, as to render its discrimination extremely difficult and uncertain. But a still stronger objection to typhus, as a source of evidence on this subject, is, that by no inconsiderable number of writers it is denied to be contagious at all. On this topic a controversy has been carried on, into which I decline to enter. My own conviction, founded on very extensive observation of the disease during more than twenty years of private practice, and still more as physician to the Manchester Infirmary, Dispensary, and Fever-wards, is that, *under certain circumstances*, typhus is decidedly contagious; although by strict attention to cleanliness and to free ventilation, the effluvia issuing from the sick may be so diluted and carried off, as to be rendered almost harmless.

My determination to reject the contagion of typhus as a subject of experiment was, however, changed, by learning from Mr. Johnson, the resident clerk of the Fever-wards in this town, that there was at that time in the house a singularly well-marked case of the disease. The physician also, to whose charge the patient (a female, æt. 19) had devolved, assured me that he had not, during the last two or three years, met with a case which he could more confidently pronounce to be contagious typhus. Its severity was proved by its terminating fatally, notwithstanding the most assiduous attentions, on the fourteenth day of the disease. During the night, between the tenth and eleventh days of the malady, a flannel jacket, made without sleeves, was placed in contact with the body of the patient. On the following day, it was replaced by another ; and that, on the day after, by a third ; each of which was worn by her for several hours. The first waistcoat, after being submitted to a temperature of 204° or 205° Fahr., for an hour and three quarters, was kept beneath, and within twelve inches from, the nostrils of a person engaged in writing during two hours. The second, after being heated in a similar manner, was worn next the body of the same individual for two hours. The third, after exposure to heat, was kept in an air-tight tin canister for twenty-six days, with the view of giving activity to any contagious matter, which might possibly have escaped decomposition. It was then placed within twelve inches of the face of the same person for four hours ; a gentle current of air being contrived to blow upon him, from the flannel during the whole time. No injurious effects were experienced.

The negative results thus obtained are only, I am well aware, entitled to that proportional share of weight, which would have been due to them, if they had formed a part of a numerous series of experiments. For the reception of contagion, even by a person situated within its sphere, depends so much on predisposition, and on other circumstances, that a much larger induction of facts would be necessary, to establish the absence of *fomites* in any case like the foregoing. I do not, therefore lay much stress on so limited a number of facts. It may be proper however, to mention, that, during the first trial, the person subjected to it was much fatigued by previous exercise ; and that at the close of it he had observed an unbroken fast of eight hours,—a state of the animal system extremely favorable to the efficacy of contagion, if any had been present.

In Scarlatina, however, (including both *scarl. simplex.* and *scarl. anginosa)*, we have a disease admirably adapted for furnishing the necessary evidence. No one doubts of its being infectious. Perhaps, indeed, of all the diseases with which nosologists have arranged it (the *exanthemata*,) it gives birth to the most active and durable contagion. The interval, between exposure to infection and the commencement of the disease, is unusually short, and may be stated at from two or three, to six days. When the infection has been received, the malady produced by it, begins to be contagious before the scarlet efflorescence appears; and it continues so even after the subsequent desquamation of the cuticle. Every medical practitioner of much experience must have been baffled in his attempts to dislodge it from families, in which it had gained a footing. In such cases, its revivals at distant intervals of time has been sometimes traced to clothes or bedding which had been carelessly laid by, without being sufficiently purified. In the state of *fomites*, this species of infection has lain dormant many months. Dr. Hildebrand, for example, relates that he carried the infection in a coat, which had not been worn since his attendance on a scarlatina patient a year and a half before, from Vienna into Podolia, where the disease had till then been almost unknown.* Generally speaking, too, scarlatina is a distinct and well characterized disease; and whenever it is otherwise, the doubts may commonly be removed, by comparing it with the prevailing epidemic.

These considerations rendered me extremely desirous to try the disinfecting powers of elevated temperatures over the contagion of scarlatina. It fortunately happened that in one of the wards of the House of Recovery, a patient (a female, aged nineteen, of the name of Gerrard) was suffering under that form of the disease, which has been termed *scarlatina anginosa.* The symptoms in the judgment of the attendant physician, as well as in my own (taken in conjunction, too, with the previous history of the case), left no doubt of its nature. To make the most of this excellent example of the malady, a succesion of flannel waistcoats were worn, each for several hours, in contact with the body of the patient, and were then put into dry bottles, which were well corked, tied over with bladder, and laid by for use. Other opportunities of obtaining waistcoats, similarly infected soon occured, in the case of Sarah Gerrard, a younger sister of the first patient; of William Johnston, æt. eleven; and of Robert Green, æt. fifteen. In Johnston, not only were the appearances quite unequivocal, but he was the last of four children, (not all of one family,) who had been infected, in regular sequence, by communication with each other.

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* Dict. de Med. xix. p. 156.

1. A waistcoat, which had been worn all night by the elder Gerrard, a day or two after the appearance of the scarlet eruption, was heated four hours and a half at 204° Fahrenheit, and on the 8th of November, was applied to the body of a boy, æt. six years. No symptom having shown itself on the 15th, a second waistcoat was then applied to him, which had been worn more than twelve hours by Johnston on the second day of the scarlet efflorescence, and then heated at temperatures varying from 200° to 204° Fahrenheit, during two hours and three quarters. After an interval of twenty-two days the boy, who still continued to wear the same waistcoat, remained perfectly well.

2. A waistcoat, which had been worn twenty-two hours by the elder Gerrard on the fourth and fith days after the appearance of the eruption, was on the 19th of November heated three hours at 204°. It was, after this, worn by a girl, aged twelve years, till the 30th, without effect. Another waistcoat, which had been worn by Sarah Gerrard, was then substituted but without any effect ensuing.

3. A waistcoat, put on by Sarah Gerrard on the second day of the efflorescence and worn by her for three days, was applied, Nov. 19th, after it had been heated two hours at 200°, to the body of a boy aged ten years. On the 30th a second waistcoat, which had been worn by Robert Green during the first and second days of the eruption, and which had been kept in the disinfecting apparatus at 204° during one hour only, was substituted; but no symptoms of infection have appeared.

4. A waistcoat, which had been worn by the elder Gerrard seventeen hours on the 7th and 8th of November, (the second and third days of the eruption,) was kept closely corked up in a bottle till the 25th, then heated four hours and a half, at temperatures varying from 200° to 206°, and applied to a girl aged thirteen years. On the 30th of November, no effect having been produced, another waistcoat was substituted, which had been worn eleven hours by Johnston on the third day of the efflorescence, and then disinfected by a temperature of 204° applied during two hours. No symptoms of scarlatina have shown themselves in this case.

In all the foregoing intances, it was ascertained by the most careful inquiries that the children, to whom the disinfected waistcoats were applied, had never been affected with the scarlatina, and therefore liable to that disease. The children were attentively examined every day, in order that no slight symptom might pass unobserved.*

The experiments, which have been related, appear to me sufficiently numerous to prove, *that by exposure to a temperature not below 200° Fahr. during at least one hour, the contagious matter of scarlatina is either dissipated or destroyed.* To me it seems more probable that it is *decomposed,* than that it is merely *volatilized;* because cow-pock matter, though completely deprived of its volatile portion at 120°. is not rendered inert by temperatures much below 140°. I did not, however, consider it as either necessary to the proof, or justifiable, to determine, with respect to the contagion of scarlatina, either the lowest temperature, or the shortest time, adequate to the disinfecting agency; for these points, which are of no practical importance, could not have been decided without the actual communication of the malady. Still less necessary, and less justifiable, should I have thought it, to have proved, by exciting the disease, that, the waistcoats, as taken from the patients, were impregnated with the contagion of scarlatina.

It may, I am aware, be urged that the induction would have been more satisfactory, if founded on a greater number of instances. But experiments, of the kind which have been related, are attended with so many difficulties, as to forbid their multiplication beyond what is absolutely necessary. Not to mention other obstacles, it is far from easy to find young persons in every respect unexceptionable for the purpose;—to insulate them, as was done in these instances, from all casual sources of infection;—and to keep them under the watchful care of observers, qualified to mark even indistinct symptoms that might arise, and to apply the proper remedies. It must be acknowledged also, that the inference from the destructible nature of the *fomites* of scarlatina, to that of other contagions, remains analogical; and that experiments are still wanting to extend the proof to other known species. The argument, however, in its nature cumulative, has acquired a great increase of probability by the step which has been made, in showing that the power of heat is not merely exerted over cow-pock infection, but extends to the active and virulent contagion of scarlatina.

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* It is due to Mr. Edward Johnson, resident clerk of the Manchester House of Recovery, that I should acknowledge his valuable assistance, especially in the care with which he superintended the disinfecting processes.

The circumstances under which the experiments were conducted, render it, I think, demonstrable *that the disinfecting agency belongs to heat alone;* for the receptacle, in which the infected waistcoats were placed, having in every instance been closed, change of air could have had no share in the effect. The phænomena, then are reduced to their simplest form and the results put us in possession, of a disinfecting agent, the most searching that nature affords ;—one that penetrates into the inmost recesses of matter in all its various states. As a disinfectant of articles which are capable of imbibing and retaining contagion, heat is greatly superior to the vapours or gases used for the same purpose ; inasmuch as the transmission of the latter may be stopped by a few folds of compressed materials ; while heat, if time enough be allowed, finds its way in spite of all obstacles. To avoid being misunderstood, I must however repeat, that it is to the destruction, by heat, of contagion existing in substances technically called "susceptible," that I limit the proposal ;—for instance, to infected clothing of every description ; to infected bedding and bed-furniture of every kind that would be spoiled by washing ; to trunks and other packages brought by travellers from infected places ; and to merchandize, whenever it can be shown, or rendered highly probable, that such merchandize has been in the way of imbibing contagious matter.*

This is not the fit occasion for obviating anticipated difficulties, arising out of the consideration of practical details. A few of these have been candidly stated to me, and have led to actual trials, chiefly as respects time and labor, the results of which have been satisfactory to the objectors themselves. The remaining element of calculation, the expense of apparatus and fuel, I am unable to supply ; but much observation of the use of steam, on a large scale, induces me to believe that the cost of producing and of applying it to this purpose would be far more than compensated, by the great and mani-

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* After taking great pains to obtain information, I have not been able to satisfy myself whether any, and what amount of danger exists from the presence of contagion in merchandize. There is one article, however, which is more likely than any other to be a vehicle of infection, viz. *old rags*, of which large cargoes are constanly imported into this country.

Letters, which are often rendered almost illegible by fumigation, might be disinfected in this way, if closed not with sealing-wax, but with wafers. Writing-paper I find by experiment, begins to turn brown a little under 300° ; but it still retains its texture, and the ink is not materially changed.

fest advantages of abridging the duration of quarantine,—perhaps of supplanting it altogether. I do not, however, consider steam as an essential vehicle of heat for disinfecting purposes. Temperature, in whatever manner it may be raised, will doubtless be found adequate to the effect. It is probable that a current of air, heated within a safe point, on the plan invented by the late ingenious Mr. Strutt, of Derby, and now applied to so many useful purposes in manufactures and domestic economy, might accomplish the end at much expense of time and money.* All that I attempt is to furnish the principle; its application I leave to experienced engineers in this and other countries. After the most attentive consideration, I can myself discover no objection to the execution of the plan, that may not be surmounted by a reasonable share of zeal and perseverance; and without the exertion of those qualities, no important improvement was ever carried through all its stages,—from its first suggestion to its final and complete establishment.

That the quarantine laws of every civilized country require to be carefully revised, and to be entirely re-modelled *by mutual agreement between different nations*, does not admit of a doubt. In their present state, they are both oppressive and inadequate. They demand observances that are of no use, and overlook others that would be really efficacious. They impose grievous and needless restraints on personal freedom; they fetter commerce and navigation; they abridge the demand for produce and manufactures; and, thus, by making scant the means of life over wide and populous districts, they nourish discontent, increase all the sufferings attendant on poverty, and give rise to *inborn* diseases, far more spreading, and scarcely less severe, than those against which they are intended to act as barriers.

The basis, however, of a wise and beneficial system of quarantine laws,—of such a system as, while it affords all needful security against the introduction of contagious diseases, shall trespass no more than is absolutely unavoidable on the vital interests of trade and commerce,—can only be found in a collection of well ascertained facts respecting contagion. Of these it is not beyond the

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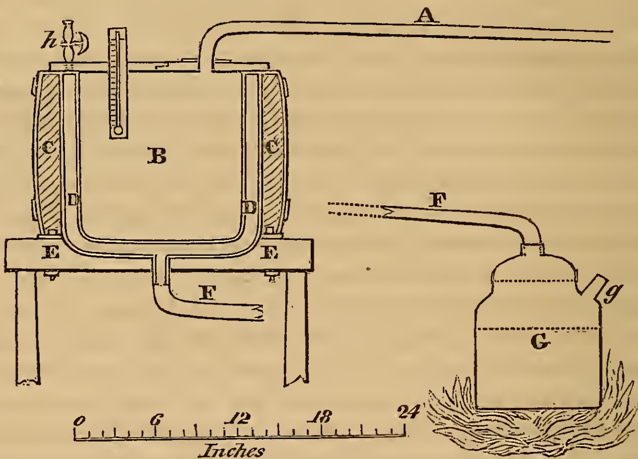
* See "the Philosophy of Domestic Economy," by Charles Sylvester, which contains a full account of Mr. Strutt's plans, as carried into effect at the Derbyshire General Infirmary, 1 vol. thin 4to. Published by Longman and Co., London, 1819.

truth to assert, that there is a lamentable deficiency. It has unfortunately happened, that the phænomena of contagion have generally been investigated, at times when the quarantine laws have been under the deliberation of Parliament; and this with a view to supply evidence, which, however, honest and sincere, has been collected from observers, on both sides, who were under the influence of preconceived opinions. But it is not at such seasons, or in such a spirit, that so difficult and momentous an inquiry should be instituted. It must be begun, and pursued, in that dispassionate temper, which leaves the mind at liberty to examine phænomena with patience and accuracy; and to reason upon them with no other purpose, than that of deducing incontrovertible conclusions:—conclusions upon which, and upon which alone, *rules of practice*, of the greatest benefit to mankind, may be founded, as the final issue and reward of the investigation.

DESCRIPTION OF THE APPARATUS.

The apparatus employed in the process of disinfection is so simple, that a representation of it can only be required by those who are not conversant with the application of steam as a source of heat. The object, in this instance, is to place articles of clothing, &c. which are intended to be disinfected, in a steady temperature, above 200° Fahrenheit, for any required length of time, without, however, allowing the steam to come in contact with the substances so exposed. This is effected by two vessels of copper, or of tinned iron, on the innermost of which the letter B stands in the sketch. The latter vessel is set within a larger one of similar shape, upon the edge of which it rests by a rim, which is united to the larger vessel by solder. There is, therefore, a cavity between the two vessels, shown by the letters DD, for containing the steam. The bottom of the outer vessel is a little dished or sloped downwards, and to the central part is soldered a short pipe for admitting steam and returning water; the space, on the centre of which the letter B is placed, is the *receptacle* for the articles, which are to be heated. To avoid the waste of heat through the sides of the outer vessel, it is packed all round, as shown at CC, with any non-conducting substance, such as hemp, bands of straw, or rolls of flannel. To prevent these from being displaced, they may be surrounded by barrel staves secured by hoops of wood or metal. Over the top of the apparatus a wooden cover is applied, which being rabbeted along the middle, as shown by the sketch, admits either of one half or the whole of the cover being removed at pleasure. From this cover, towards the right, a pipe A proceeds, the only object of which is to carry into the flue of the chimney any infectious effluvia that may possibly escape undecomposed. The thermometer is introduced occasionally through a slit in the other half. The small air cock *h*, which is removable at pleasure, passes through an aperture in the same half of the cover; and when open establishes a communication between the space DD and the atmosphere. The whole vessel rests on a table EE (the legs of which are represented as if broken off,) hollowed out to receive it. To this table the vessel is fastened by four small bolts, the extremities of two of which are shown by the sketch. To give a hold to the heads of these bolts, *a flanche* is soldered near the bottom of the outer vessel, which has also a corresponding *flanche* at the top, for the purpose of keeping the packing in its place.



The small boiler G has a movable lid, from the center of which issues a pipe FF, five or six feet long, or any other convenient length, which slips over the pipe that descends from the steam-vessel. To bring the drawings into less space, this pipe is represented with a part broken off. The dimensions of every part of the apparatus are given by the scale, annexed to the sketch.

The vessel G is to be filled about two-thirds with water, which to save time, may be nearly boiling at the outset. Being set over a fire, and the joints that require it having been made good by flour-paste spread on paper, the opening *g* is to be shut by a cork or plug, and the small air-cock opened, to allow the escape of the air confined in the space DD. Both halves of the cover being then put into their places, the thermometer is to be introduced through the slit. When it indicates upwards of 200°, that half of the cover from which the pipe A proceeds* is to be removed; the infected articles are to be placed in the receptacle, and the half-cover replaced. The fire under the boiler is to be regulated, by the rate at which the excess of steam issues from the small air-cock. This excess, if found inconvenient by its escape into the room, may be conveyed to the outside by a pipe of the necessary length, screwed upon the tapped end of the air-cock. Hot water will require to be occasionally supplied through the aperture *g;* but unless the steam be unnecessarily wasted by too large a fire, this need not be done often; as what is condensed in the cavity DD is constantly trickling back into the boiler through the pipe FF.

The dimensions and shape of the apparatus, and the material of which it is made, may be varied according to the extent of the operations for which it is intended. For domestic purposes, a common tea-kettle, by stopping the spout with a plug, and making the necessary additions to the lid, will answer perfectly well; and a cheap and simple disinfecting vessel resembling B may easily be contrived. For large operations, a boiler of sheet-iron, resembling that of a steam-engine, will be necessary. If thought expedient, a higher temperature than 212° Fahrenheit may easily be obtained in the receptacle, by subjecting the steam to a greater pressure than that of the atmosphere; the apparatus being in that case provided with a proper safety valve.

If heated air should be found adequate to the effect, it might be employed for ordinary articles, reserving the more costly vehicle, steam, for articles which are of great value, and which are easily injured.

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* The pipe A will be found much more convenient if made in two parts, the part attached to the cover being not more than a foot long; its open end being made to slip *into* the longer part, as a few drops of moisture always escape.

Art. XI.—*Remarks* upon the Natural Resources of the Western Country.*

In the perusal of our Scientific Journals, as well as of those books which contain the localities of different minerals, we are surprised to find the little mention that is made of the Western Country. Why is this the case ? Is it because the west is deficient in natural productions ? Certainly not. The testimony of the few scientific men, who have travelled through those parts, is amply sufficient to convince any one, (who might suspect the partiality of nature,) of the great abundance of her productions in the western mountains. The true explanation of this neglect, if I may so call it, arises partly from the fact, that very few scientific men have travelled through and explored those regions ; but principally, from the pursuits of the inhabitants themselves ; who, having to prepare their lands for cultivation, had at first, but little time to spend in searching for the treasures of the earth, further than immediate necessities required.

But as this period of *preparation* is almost past, and the people are becoming settled in life, they only want an impulse, to engage in scientific pursuits themselves. This impulse can be given by their more scientific countrymen of the East. Here then is a wide field for the talents, industry, and patriotism of our mineralogists, geologists, and other students of nature. By an examination of these regions, they will not only confer an important benefit upon science, but they will do an essential service to the western states.

I think I may say with safety, that the Cumberland, and the southern part of the Allegany mountains, contain many and large beds of ores, of the value of which the people are entirely ignorant. It is not necessary that each of these beds should be pointed out to them. When they have once conceived a proper idea of their importance ; when they have found that these mines contain wealth, they will search for themselves. A scientific spirit must be infused into the minds of the people. The Spaniards found more gold in South America than the Indians ever would have done : and why ? Because they knew the importance of this metal. But supposing the

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* Desirous to aid every effort to excite inquiry into the resources and natural productions and antiquities of our vast and prolific western regions, we insert this communication, although the writer appears not fully to appreciate what has already been done on this subject.—Ed.

people to be acquainted with the value of a metal, or of a particular mineral; still they must receive an impulse, before they will search for it. The gold mines of the south might have still lain in the bosom of the earth, had not the accidental discovery of gold in one of the states, informed the people of its existence; and engaged their *interest* in its search. And by this investigation which is not yet completed, a formation of gold has been found, running nearly parallel to the Allegany mountains, and extending through Georgia, part of Tennessee, the Carolinas, and Virginia. The rich iron mines of the Cumberland mountains, were not worked, until the scientific investigation of one of them in Western Virginia, proved the profit of the reduction of these ores. Since that time, mines have been opened along the whole chain, extending from Virginia through Tennessee into Alabama. These mines it may be observed, afford enough iron for a large extent of country: and should a communication be opened between them and the sea, a much larger quantity will be extracted for the purpose of exportation. With the Galena mines, we are well acquainted. They have reduced to one fourth of its former value, a metal of universal and almost indispensable use. There have been a few other mines discovered in the western country. I say *a few;* not because there are but few, but because, for the two reasons I have given, that the people do not properly estimate their worth, and that science has not yet engaged them in the search.* It is with a view to the removal of the last of these reasons, (upon which the former depends,) that I have written these remarks; hoping that some of your scientific readers would be induced by proper encouragement, to volunteer in the cause of natural science and improvement.

But besides the great variety of minerals in the West, there are other subjects worthy of a scientific investigation. I mean, the remains of human beings, of their labor, and of animals of each of these there is a great abundance.

1. The remains of human beings. These are to be found, sometimes buried, but generally in caverns. They exist in the greatest

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* The following story will perhaps not be believed by some of your readers, although it is true. A small bed of ore was discovered a few years since in one of the Western States, and a dispute immediately arose between the owner and his neighbors, about the *kind* of ore it contained. The former thought that it was galena, and the latter, that it was iron ore. And because of this uncertainty the mine was not worked.—The ore was perhaps a compact oxide of manganese.

abundance, in the caves of Tennessee, and the southern parts of Kentucky. In 1828, two mummies were discovered in a complete state of preservation, in a cave in West Tennessee; and from the facts which have been disclosed by an examination of their forms and complexions, as well as of the manner in which they were entombed, we may infer that they belonged to another race, and one anterior to the present race of Indians. I believe that a part of one of these remains has been lodged in the New York museum.

In one of the caverns of East Tennessee, which I visited in 1824, I found a very large number of human bones; and, indeed, in passing through the cavern, they formed my only pavement for almost an hundred yards. Some of the bones were very large, and indicated (by measurement) that their former owners were but little under seven feet in height. The skeletons were not laid in any particular order, but appeared to have been thrown in, indiscriminately. The bones of animals were also mixed among them. I suppose it is generally known that the greater part of these caves contain nitre (salt-petre earth.) The one I visited, however, contained but little. On my egress from the cave, I saw some fine specimens of *fluor* attached, in crystals, to the sides of the mouth, which thus appeared highly ornamented.

A very curious graveyard was discovered, some years ago, in Middle Tennessee. The persons that had been buried were very small, perhaps not more than three or four feet in height. The graves, which were made to correspond in size, were very shallow. A stone laid in the bottom, one on each side, and one on the top formed the simple domicil of these little beings. A small earthen vessel was placed in each grave: the use for which we are as much at a loss to understand, as we are to account for the existence of the graves themselves.

2. The labors of a past race of human beings are every where visible in the Western Country. And this is particularly to be observed in the mounds of earth, which are very numerous in Ohio, Kentucky, and Tennessee. The mounds and remains of an ancient fortification, upon which the city of Cincinnati is built, have often been described. The implements of war and husbandry, which have been found with these remains, are very curious and offer to the mind of the Antiquarian much that is interesting and instructive. I am informed, by a respectable gentleman, that some miles above Cincinnati there is a large annular mound, (on which the town of Circle-

ville is built,) which is surrounded by four smaller ones, situated on the outside of the former, and on the prolongations of two rectangular diameters. Would it not be a matter worthy of investigation to determine what could have been the use of these works?

3. The remains of animals in the West, though less numerous than the two former kinds, are still very interesting; and some of them are quite peculiar. The gigantic animal bones found in Kentucky, are perhaps different from any known species or genera. Of this, however, we shall be better informed when they shall have been examined by scientific men;* and I understand that they are now undergoing that examination in Europe. Other remains of animals have been found on the banks of the Mississippi, and in the State of Georgia; but for the want of persons capable of investigating them, but little is known of their peculiarities.

Mr. Flint of Kentucky, has done much for the natural history of the Western States; and it is to be hoped that he will yet do much more.

An Antiquarian Society has been established in the State of Indiana, for the sole purpose, I believe, of investigating the history, &c. of the Aboriginals of that country. I have not yet seen any of their proceedings, but to judge from the characters and talents of the members and the materials they have at hand, I should say they would effect much for the cause in which they are engaged. The Legislature of Tennessee, with a truly enlightened patriotism, has lately passed a law creating a professorship of Geology and Mineralogy for the State; and it is much to be desired that other States should follow the example.

The above remarks contain a notice of only a very small number of the objects worthy of a scientific investigation in the Western Country. K.

West Point, February 10, 1832.

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* Our correspondent does not appear to have read the very exact account of these bones, given by Dr. De Kay and Mr. Cooper, of New York.—See this Journal, Vol. XX, p. 370.

Art. XII.—*On the Artificial Preparation of cold Medicinal Waters, by* William Meade, M. D.

The late illustrious Bergman, having devoted much of his time and applied his great talents to the investigation of the nature and properties of mineral waters, appears to have been the first person who suggested and proved, that an artificial preparation of them, founded upon an exact knowledge of their contents, may produce the same medicinal effect, and be equally beneficial to health, as the natural waters. He states, that he was induced to this attempt by the difficulty of obtaining in Sweden, where he resided, some of the most celebrated mineral waters, such as those of Seltzer and Pyrmont. Besides the great expense and inconvenience, their valuable qualities were much injured, by conveying them to such a distance from the spring and keeping them in bottles, at a season of the year when they are considered indispensable to the removal of those diseases which originate from the severity of the climate, during a long winter.

Bergman then proceeds to observe, that however useful may be the discovery of imitating perfectly these mineral waters, it cannot possibly be universally pleasing; many who are incapable of judging of the truth, will distrust it, and many contend that to imitate nature is impossible, without considering that when the component parts of a substance are known, the success of the process cannot depend upon the hand which combines them; some who prescribe, and others who sell the foreign water, condemn the artificial, for obvious reasons; besides, the negligence or ignorance of an inexperienced person may easily defeat the whole operation. All these obstacles, however, did not discourage Bergman from the artificial preparation of cold medicinal waters, at Upsal, and the use of such waters became general, although at first proposed only in cases of necessity, when the natural waters could not be obtained, and he further observes, that they produce the same good effect as the natural waters, and in some instances seem to excel them.

The knowledge of Bergman's success, in introducing so advantageous a substitute for the natural medicinal waters, soon extending itself into various parts of Europe, was fully appreciated, and the practice came into such general use, that in England the waters of Pyrmont, Spa and Seltzer, were prepared artificially, and substituted for the natural waters, which had been previously imported in large quantity from their respective springs. The artificial waters were even preferred there, not without sufficient reason, as it is well known to all who are acquainted with the subject, that the substances which are most essential in these mineral waters, are carbonic acid gas, with a small proportion of a neutral salt, an alkali and a little iron and magnesia, all of which can be combined with pure water, and in greater quantity than in the natural spring.

From the time of Bergman's attempt, in the year 1771, to introduce the artificial mineral waters into general use, where access could not be easily had to the natural spring, other chemists of great celebrity turned their attention to the subject, sanctioning the attempt and pointing out how other medicinal waters besides those already mentioned may be imitated artificially. About twenty years after the publication of Bergman's essays, Kirwan produced his celebrated treatise on the analysis of mineral waters; induced to this attempt, as he observes, by "the advantages which mankind have derived from their medicinal effects, and from the necessity of a knowledge of their contents, in order to prescribe them in cases of disease where they are applicable, as well as to imitate such as are found beneficial, in countries where they have not been discovered or where they cannot be procured in a state of purity."

The ancients were not unacquainted with the medicinal qualities of certain mineral waters, but were entirely ignorant of the nature of their contents, and of the qualities that result from their combination. Pliny, with his usual sagacity, at so early a period as the year 79, when writing on the subject of natural history, observes, "Tales sunt aquæ qualis terra per quam fluunt," thus showing that he was aware, even at that time, in what manner waters received their impregnation. He proceeded, however, no farther, nor was it until several centuries after his time, that a knowledge of chemistry taught us how to discover, with some accuracy, what are the ingredients of mineral waters, and whether they possess medicinal qualities or not.

Many persons are persuaded that there is something mysterious in the natural production of mineral waters, which could never be either explained or imitated; we now know, however, that the mineral water is only a compound of the water itself and of those substances which it holds in solution. It can therefore be of little consequence, whether by passing through the bowels of the earth it extracts different materials from certain strata over which it flows, or whether these substances, in the proper quantities, be artificially added to the water; the hand that supplies these materials, as Bergman so justly observes, can make no difference in the result.

In order to illustrate this subject by a familiar example, I shall now endeavor to explain how one of the least complicated medicinal waters may be effectually imitated, leaving no doubt in the mind of any unprejudiced individual, that the artificial preparation is precisely similar to the natural water at the spring.

For this purpose, I shall select the water at Epsom, in England. The taste of this water was so peculiarly saline, that at a very early period of time it was used medicinally and found to possess valuable qualities as a cathartic, but the nature of its contents was then unknown, and it was not until the discoveries of Black, Bergman, and other chemists, that the real properties of sulphate of magnesia were investigated, when it was soon ascertained that the Epsom water derived all its qualities from this neutral salt; therefore, from having been extracted from it in large quantities by evaporation, it has since been denominated Epsom salts, and, as is well known, it is used medicinally when dissolved in common water; thus, even at so early a period, forming an artificial preparation which had precisely the same taste and possessed the same medicinal qualities. When further investigating the properties of magnesia, it was found that the salt which was supposed to be peculiar to Epsom water could be easily prepared artificially, in a direct way, by the union of sulphuric acid and magnesia; all mystery disappeared, and it was apparent that this spring possessed no quality which any other water impregnated with sulphate of magnesia may not be easily made to possess.

There is another mineral water, of a rather more complicated nature, to which I shall now allude; it is the celebrated Cheltenham spring, in England, which is perhaps as much frequented as any in Europe; it is however stripped of all its mystery, when it is known that its medicinal qualities are derived, chiefly, from an impregnation of neutral salts, such as sulphate of soda and sulphate of magnesia, in the following proportions; eighty grains of sulphate of soda and forty grains of sulphate of magnesia, with about seven grains of muriate of magnesia and lime, with scarcely an appreciable quantity of iron, and only seven cubic inches of carbonic acid in one quart of this water.

In order to obtain those substances on which the medicinal qualities of the Cheltenham water principally depend, the salts are procured on the spot by evaporation and crystallization, and sold at a high price, under the name of Cheltenham salts; but as these can be nothing more than a mixture of sulphate of soda and sulphate of magnesia, in the above proportions, it is evident that salts possessing the same qualities, when dissolved in common water, can be artificially prepared, and sold for the same purpose, at a comparatively trifling expense. Thus are the ignorant imposed upon, from not knowing that neutral salts, of the same species, possess the same qualities, from whatever water they are produced. Although these salts are the chief ingredients in Cheltenham water, they cannot be said to be the only ones, and in order to imitate exactly the natural water, recourse must be had to the usual method of impregnating water with carbonic acid gas, and supplying a small quantity of iron, in addition to the salts—ingredients much relied on at Cheltenham, but which in fact, as I have ascertained myself on the spot, are found in it in such small quantities as to be scarcely noticed or to add much to the medicinal qualities of the water.

The practice of substituting artificial crystallized salts for those obtained from the natural springs at Cheltenham, was so successful, that a similar attempt was made to impose on the ignorant, by collecting the residuum obtained by evaporation from the waters of Harrowgate, and even to imitate this residuum, and recommend it, when dissolved in water, as a substitute for the water at the spring; this, however, did not, nor could it, indeed, continue long to impose on the public. When the real causes of the properties of Harrowgate waters were discovered, it was ascertained that they resided in other substances than the mere neutral salts, and that these substances could not be obtained by evaporation, but on the contrary were dissipated by the process. These substances were carbonic acid gas and sulphuretted hydrogen gas, imparting peculiar properties to the water and assisting in the solution of others. When the water was evaporated, the residuum of course, possessed none of its most valuable properties, but when dissolved in common water, became a most nauseous, and somewhat inert draught, possessing no longer any medicinal effect, except what it derived from the neutral salt which was deposited by close evaporation. The same mistaken view of this matter subsisted for a length of time in this country, and is still carried into practice at Saratoga, by evaporating the water of the Congress spring, and they collect the residuum to be dissolved in common water, and to be used medicinally; but whatever foundation there may be for such a practice in the case of the simple saline spring at Epsom, and others, nothing can be more improper than pursuing it with the Congress water, the residuum of which, after evaporation, consists of various substances, some of which are perfectly inert after the carbonic acid has been expelled; thus composing a mixture partly insoluble, and not only nauseous to a degree, but actually not free from qualities which are injurious to the system when taken in any quantity.

Since the properties of carbonic acid gas have been investigated by Black, Priestley, and other chemists, much light has been thrown upon the most important phenomena in nature, but on none more than in explaining the nature and properties of mineral waters. It has been shown to be the principal agent in their production as well as in promoting the solution of several substances which are otherwise insoluble in pure water. It is this gas which holds the iron and earths in solution; it is this which gives the agreeable pungent taste to the water, and it is also this gas which produces that exhiliration of spirits which almost all persons feel after drinking such waters. As soon as it was ascertained that water could be impregnated with this gas, and that it then resembled, in every respect, the waters of Spa, Seltzer, and Pyrmont, it was immediately proposed to make use of it to imitate the taste and medicinal qualities of those natural springs. Bergman accordingly took advantage of this discovery, and although at that time the process of impregnating water with carbonic gas was not as well understood as it is at present, yet he succeeded in imitating effectually all those mineral waters with which he was at that time acquainted, and thus rendered to his countrymen a most important service. The apparatus for conducting the process of impregnating water with gas has been, since that period, so improved, that by an instrument adapted to the purpose, carbonic acid gas has been forced into water, to the quantity of three times its bulk, much more than any water can take up by the common process of nature.

The experience of many years has not lessened the confidence of the public in the use of these artificial mineral waters, it having been found that their medicinal qualities are equal to those of the natural spring, and that in many instances they may be rendered superior, by adding, if necessary, a larger quantity of the most useful substances or by omitting others which are either unnecessary or injurious to health.

It would be superfluous to attempt to describe here the present method of impregnating water with carbonic acid gâs; the principle upon which it is practiced, is the basis upon which depends the artificial production or imitation of cold medicinal waters: water saturated with this gas alone has, for a long time, become a favorite, and even a salutary beverage in the summer months, but when sub-carbonate of soda is added to the water, it imparts to it peculiar medicinal qualities, and is the article which is now familiarly known as soda water, prepared for general use in all the large cities. No general method for preparing an artificial mineral water is superior to this; it is only necessary to add, in proper proportions, these substances which peculiarly characterize any particular mineral spring, and by impregnating the water with carbonic acid, the imitation is complete. On the same principle may sulphureous waters, such as the *Harrowgate*, be prepared by adding to common water the necessary quantity of those which are found in it, and then saturating it with sulphuretted hydrogen gas.

Having now shown the facility with which artificial medicinal waters may be prepared, resembling the natural waters not only in taste but in medicinal qualities; it must still be acknowledged, that many of the same objections which have been stated with respect to the natural waters, exist with respect to the use of the artificial at any distance from the place where they are prepared; such is the difficulty of preserving them in bottles for any length of time without materially injuring their medicinal qualities by the escape of the gas which imparts one of their essential properties; there is a serious risk and difficulty in transporting these bottles to foreign countries, and more particularly to warm climates, where they are often peculiarly valuable, and where they cannot be procured without great inconvenience and expense. To substitute another method of making an artificial preparation which would not be liable to those objections became a great desideratum.

(To be continued.)

Art. XIII.—*On Central Forces; by* Prof. Theodore Strong.

(Continued from p. 342, Vol. XXI.)

It is evident by the equation $v^{\circ}=\frac{180^{\circ}}{\sqrt{n}}$, that the angle v° between the apsides is always possible and finite when n is any positive number >0; but if n is any negative number v° is always impossible; also if $n=0$ or $F=\frac{A}{r^3}$, the angle between the apsides is infinite; Prin. sec. 9, B. I, prop. 45, cor. 1.

Again, let $\frac{\varphi r}{r^3}=A\left(\frac{r-cr^4}{r^3}\right)$, c=const. then $v^{\circ}=180^{\circ}\sqrt{\frac{dh.l.r}{dh.l.\varphi r}}=180^{\circ}\sqrt{\frac{1-cr^3}{1-4cr^3}}$, or by expounding r (or R,) by unity, $v^{\circ}=180^{\circ}\sqrt{\frac{1-c}{1-4c}}$; Prin. cor. 2, to the prop. cited above. Finally, the curves denoted by (19) can be constructed by an ellipse whose focus is at the centre of force, R'= its semi-parameter, and $R'(1-e)$= R= its perihelion distance. For let the perihelion distance make the angle $v-mv$ with the line R drawn from the centre of force to the place of the particle at the origin of the motion; also let r' denote the value of r between the centre of force and perimeter of the ellipse. Now since r' makes the angle v with R, and as the perihelion distance makes the angle $v-mv$ with R, ∴ r' makes the angle $v-(v-mv)=mv$ with the perihelion distance; hence by the property of the ellipse $r'=\frac{R'}{1+e\cos. mv}=R'(1-e\cos. mv)$, neglecting quantities of the order e^2; but by (19) $r=R'(1-e\cos. mv)$ ∴ $r'=r$ and the particle is at the extremity of r' (in the ellipse,) which makes the angle v with R. Hence by supposing the ellipse to revolve around the focus, so that $r'=r$ always makes the angle v with the fixed line R, the particle will always be in the perimeter of the ellipse, and the angular motion of the perihelion distance will be $v-mv$; ∴ we may suppose the curves denoted by (19) to be generated by the motion of the particle in a moveable ellipse; whose plane revolves around the focus so that the angular motion of the particle is v, and that of the perihelion $v-mv$, or so that the angular motion of the particle is to that of the perihelion as $1:1-m$.

It is also evident that the particle in the moveable ellipse will be at an apsis of the curves, represented by (19) when it is at the perihelion or aphelion of the ellipse. Again, supposing (as above,) that $\frac{\varphi r}{r^3}=\frac{Ar^n}{r^3}$, then $m=\sqrt{n}$; if $\therefore n=1$, or $F=\frac{A}{r^2}$, $v-mv=v-v=0$, and the particle revolves in a quiescent ellipse; but if $\sqrt{n}$ is <1 and >0, then $v-mv$ is positive, and the ellipse revolves in the same direction as the particle, or in consequentia; but if $\sqrt{n}$ is >1, $v-mv$ is negative and the ellipse revolves in a contrary direction to the motion of the particle, or in antecedentia; in the former case the apsides are said to go forwards, or in consequentia, but in the latter backwards, or in antecedentia. Universally, whatever may be the law of force, provided that m is a positive number <1 and >0, the apsides progress; but if m is positive and >1, they regress; because the apsides of the moveable ellipse progress or regress with respect to the motion of the particle in these cases. See Prin. prop. 43, sec. 9, B. I, also cor. 7. prop. 66, sec. 11.

I will now suppose that a particle of matter is describing a curve around a given centre of force, and is at the same time attracted towards another centre of force, situated in the plane of the described curve; to determine the equations of its motion.

It is evident that the attraction towards the second centre of force will alter or disturb the motion of the particle around the first centre; I shall therefore call it (according to usage,) the disturbing force. I shall (as heretofore,) denote the distance of the particle from the first center of force at any time (t) by r, and shall suppose that v denotes the angle described by r around the centre in any time, v being reckoned from some fixed line in the plane of the motion.

Let $\frac{c'}{2}$ denote the area described by r around the first centre of force in a unit of time; then by (G), (Vol. XVI, p. 286,) $c'^2=\frac{r^4 dv^2}{dt^2}$ or $c'^2=r^2\times\frac{r^2 dv^2}{dt^2}$, (1).

If there was no disturbing force, c' would be constant; but it evidently becomes variable by its action. Let the disturbing force be resolved into two; one in the direction of r, the other perpendicular to r, which let be denoted by T; it is evident (by what was shown in Vols. XVI and XVII,) that the first of these cannot affect c', but T will render it variable.

To find the effect of T, I take the differential of (1), considering c' and rdv as alone variable; hence $c'dc'=r^3dv\times\frac{d(rdv)}{dt^2}$, but it is evident (supposing that T tends to increase rdv,) that $\frac{d(rdv)}{dt^2}=\text{T}$, $\therefore c'dc'=\text{T}r^3dv$, and by integration $c'^2=h^2+2\int\text{T}r^3dv$, (2), $\int$ being the sign of integration, and h^2 the arbitrary constant which equals c'^2 when there is no disturbing force; also by substituting c'^2 in (1) there results $dt=\frac{r^2dv}{\sqrt{h^2+2\int\text{T}r^3dv}}$, (3). Put $r=\frac{1}{u}$, then (2) and (3) become $c'^2=h^2+2\int\frac{\text{T}dv}{u^3}$, (4), $dt=\frac{dv}{u^2\sqrt{h^2+2\int\frac{\text{T}dv}{u^3}}}$, (5). Let F denote the resultant of the force towards the first centre, and of the resolved part of the disturbing force, which acts in the direction of r; then I have by Vol. XVI, p. 286, $\frac{c'^2}{r^3}-\frac{d\left(\frac{dr^2}{dt^2}\right)}{2dr}=\text{F}$, (6), which by substituting $\frac{r^4dv^2}{c'^2}$ for dt^2 becomes $\frac{c'^2}{r^3}-\frac{d\left(\frac{c'^2dr^2}{r^4dv^2}\right)}{2dr}=\text{F}$, (7).

By putting $r=\frac{1}{u}$, and making dv constant, (7) is easily changed to

$$\frac{d^2u}{dv^2}+u+\frac{\frac{c'dc'du}{dv^2}-\frac{\text{F}}{u^2}}{c'^2}=0,$$ or since $c'dc'=\text{T}r^3dv=\frac{\text{T}dv}{u^3}$, it becomes

$$\frac{d^2u}{dv^2}+u+\frac{\text{T}\frac{du}{dv}-\text{F}u}{u^3\left(h^2+2\int\frac{\text{T}dv}{u^3}\right)},$$ (8), by substituting the value of c'^2.

The equations (5) and (8) are sufficient to find the place of the particle at any given time.

Again, if the disturbing force is not in the plane of the curve described by the particle around the first centre, then imagine a fixed plane drawn at pleasure through the first centre, and let $\theta=$ the variable inclination of r to the fixed plane; put $r'=r\cos.\theta$, $\text{P}=\text{F}=$ the resultant in the direction of r' in the fixed plane.

Then change r into r', F into P, and the preceding results will be true in this case; as is evident by supposing the moving particle and the forces which act on it to be orthographically projected upon the fixed plane. In this case, a resolved part of the force towards the first centre and of the disturbing force act at right angles to the fixed plane; let S denote their resultant, which I shall suppose acts towards the plane. Let $s = \tan.\theta$, put $z =$ the perpendicular from the particle to the fixed plane; then by the theory of accelerating forces (or by (a) Vol. XVI, p. 284,) $\frac{d^2z}{dt^2} + S = 0$, or $\frac{d\left(\frac{dz^2}{dt^2}\right)}{2dz} + S = 0$, or substituting $\frac{r'^4 dv^2}{c'^2} = \frac{dv^2}{u^4 c'^2}$ for dt^2, it becomes $\frac{d\left(\frac{u^4 c'^2 dz^2}{dv^2}\right)}{2dz} + S = 0$; but $z = r's = \frac{s}{u}$, $\therefore dz = \frac{uds - sdu}{u^2}$, and $u^2 dz = uds - sdu$; hence $\frac{d\left(\frac{c'^2(uds - sdu)^2}{dv^2}\right)}{uds - sdu} + \frac{2S}{u^2} = 0$, which, by making dv constant and substituting for $c'dc'$ its equal $\frac{Tdv}{u^3}$, gives $\frac{d^2s}{dv^2} - \frac{s}{u} \times \left(\frac{d^2u}{dv^2} + \frac{T\frac{du}{dv}}{c'^2u^3}\right) + \frac{T\frac{ds}{dv} + S}{c'^2u^3} = 0$, which by substituting the value of $\frac{d^2u}{dv^2}$ and that of c'^2 becomes $\frac{d^2s}{dv^2} + s + \frac{T\frac{ds}{dv} + S - Ps}{u^3\left(h^2 + 2\int\frac{Tdv}{u^3}\right)}$, (9). Hence I have $dt = \frac{dv}{u^2\sqrt{h^2 + 2\int\frac{Tdv}{u^3}}}$, (A); $\frac{d^2u}{dv^2} + u + \frac{T\frac{du}{dv} - Pu}{u^3\left(h^2 + 2\int\frac{Tdv}{u^3}\right)}$, (B); $\frac{d^2s}{dv^2} + s + \frac{T\frac{ds}{dv} + S - Ps}{u^3\left(h^2 + 2\int\frac{Tdv}{u^3}\right)}$, (C); which are sufficient to determine the place of the particle at any given time. The equations (A), (B), (C) are the same that Woodhouse has found in a very different manner at p. 95 of his Physical Astronomy; they can easily be obtained from the equations (A), (B), (C) given in the Journal, Vol. XVI, pp. 284, 285; but I have preferred the above method, as being in some respects more simple.

Art. XIV.—*Experiments on the Expansion and Contraction of Building Stones, by variations of temperature; communicated by* William H. C. Bartlett, Lieut. U. S. Engineers.

Fort Adams, Newport Harbor, March 12, 1832.

TO PROFESSOR SILLIMAN.

Sir—In the progress of this work, we have had occasion to use considerable quantities of Coping Stones, taken from different localities, with all of which it has been found impossible to obtain tight joints. The walls, on which these stones were placed, have not undergone the slightest change; and, notwithstanding they were laid with the greatest possible care, and their joints were filled with the best cements that could be devised, yet, at the expiration of a few weeks, these joints were broken up by fissures which extended from the top to the bottom of the Coping. These fissures were supposed to have arisen from a change of dimensions in the Coping stones, in consequence of the ordinary variations of atmospheric temperature; and, with the view to ascertain if the total amount of cracking could be attributed to this cause alone, a series of experiments was instituted by order of Col. Totten, and continued from August 18th, 1830, to June 2nd, 1831. The circumstances connected with these experiments, as well as their results, you will find subjoined. Col. Totten requests me to communicate them to you, supposing that you may find them of sufficient practical importance to deserve a place in your Journal.

These experiments were made, nearly at the same time, upon *granite, limestone,* and *sandstone,* the kinds of stone used for the Coping; and for this purpose a piece of each was selected in such a manner that the three pieces were of nearly equal lengths. The granite has a fine grain, is of a compact texture, and was taken from a boulder at the head of Buzzard's Bay: the limestone is white, has a fine grained crystalline structure, and accompanies primitive rocks; it was taken from the quarries of the Sing-sing State Prison, New York: the sandstone is from the quarries in Chatham, Conn. and belongs to the old red sandstone formation, according to the Rev. Edward Hitchcock;* it has a granular structure rather coarse, and its cement is argillo-ferruginous.

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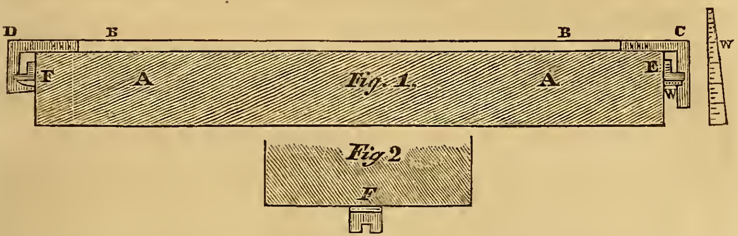
* He *now* refers all the sandstone of the Connecticut valley to the new; see the first article in the present No.

To ascertain the exact lengths of these pieces at the different temperatures produced by exposure to the weather—these alone being important for our immediate object, and for the purposes of construction generally, the measurements were made by means of a white-pine rod, with copper elbows at the ends embracing the stones when applied to them, as represented in the sketch.



AA is an elevation, or vertical section lengthwise, of the stone to be measured; BB the measuring rod, with elbows D and C of thin hammered copper, firmly secured to it. The end D was always adjusted to the same part of the stone, by sliding through a groove in the copper guide F cemented to the stone; the elbow C was adjusted in like manner by sliding through a groove in the piece E also attached to the stone. The elbow C has itself a groove through which the wedge W may slide horizontally, under the guide E, between the elbow C and the stone: this wedge being graduated as a diagonal scale showed, by the distance which it entered, the difference between the length of the measuring rod and that of the stone. The expansion of the measuring rod being known, the length of the stone could be calculated in decimals of a constant unit, viz. the English standard inch.

A groove was cut in the stone in which a Thermometer was placed, at each measurement, and being covered, was suffered to lie some time, in order to ascertain the temperature of the stone. The temperature of the measuring rod was assumed to be that of the open air to which it had been exposed.

By Lardner and Kater's Mechanics, we have as a mean between the results of Capt. Kater and Doct. Struve for the linear expansion of deal wood in terms of its length for one degree of Fahr. the decimal .00000255; and by the Edinburgh Encyclopædia, art. Expansion, we find the decimal .00000944 to express the same for hammered copper. From these data the actual length of the measuring rod was calculated for each experiment; knowing its length at sixty degrees Fahr. But to abridge the calculation, the difference in length between the stone and measuring rod, as shown by the wedge W, was subtracted from the length of the rod before making the reduction for the temperature of the latter. The length of the copper part, and that of the wooden part, were calculated separately on account of their different expansibilities. The result of this calculation is the following table.

MARBLE.			GRANITE.		SANDSTONE.	
No. of Experi.	Degrees Fahr.	Length in Inches.	Degrees Fahr.	Length in Inches.	Degrees Fahr.	Length in Inches.
1	6°	93.4155	6°	94.0251	6°	94.0180
2	7	93.4277	8	94.0330	8	94.0153
3	9	93.4201	9	94.0260	9	94.0052
4	10	93.4207	10	94.0265	10	94.0088
5	11	93.4131	11	94.0230	11	94.0124
6	12	93.4186	12	94.0282	13	94.0211
7	14	93.4174	14	94.0271	14	94.0206
8	14	93.4294	14	94.0347	14	94.0220
9	14	93.4308	14	94.0361	15	94.0235
10	16	93.4302	16	94.0285	15	94.0238
11	16	93.4291	16	94.0345	17	94.0214
12	17	93.4305	17	94.0358	18	94.0181
13	19	93.4327	19	94.0416	20	94.0239
14	20	93.4310	20	94.0364	22	94.0258
15	21	93.4316	21	94.0440	22	94.0263
16	31	93.4265	32	94.0324	32	94.0371
17	32	93.4352	32	94.0406	34	94.0466
18	34	93.4422	36	94.0330	38	94.0554
19	36	93.4360	36	94.0150	39	94.0436
20	36	93.4357	37	94.0483	39	94.0592
21	38	93.4436	41	94.0344	43	94.0486
22	52	93.4323	52	94.0348	53	94.0560
23	58	93.4450	62	94.0541	64	94.0718
24	83	93.4655	86	94.0720	93	94.0879
25	86	93.4649	88	94.0737	93	94.0829
26	90	93.4709	88	94.0688	95	94.0897
27	99	93.4677	89	94.0731	99	94.0941
28	.	. .	90	94.0693	100	94.0906
29	.	. .	91	94.0693	101	94.0944
30	.	. .	94	94.0628	104	94.0841
31	.	. .	102	94.0721	109	94.0792

It is probable that many of the discrepancies here noticed were owing to the hygrometric state of the stone; and perhaps, in part, to imperfections in the measuring apparatus; but as the hygrometric state of the stone was not recorded, we can take no account of it in our deductions. These discrepancies, however, will have but little effect upon the general result; for it will be observed, that there is always an increase in the length of stone for an increase of temperature, when any two experiments are considered which are removed from each other by several degrees.

From the facts ascertained concerning the expansion of other substances, we may assume that the expansion of stone is uniform, and that, within the range of our experiments, each of the stones increased in length by a common difference for each degree of the thermometer. To find an approximate value for this common difference, say for the granite, we subtract the first observed length from the last, and, if these experiments were accurate, the difference .0470, would be ninety six times the common difference; ninety six being the difference in degrees between the extreme temperatures: the same operation being performed with the second experiment, and that next the last; the difference .0298, (the difference in lengths,) should be eighty six times the common difference. By thus comparing the extreme experiments of those which remain, we obtain the following table.

Experiments.	Diff. in degrees.	Diff. in lengths.
1 and 31	96	+.0470
2 and 30	86	+.0298
3 and 29	82	+.0433
4 and 28	80	+.0428
5 and 27	78	+.0501
6 and 26	76	+.0406
7 and 25	74	+.0466
8 and 24	72	+.0373
9 and 23	48	+.0180
10 and 22	36	+.0063
11 and 21	25	—.0001
12 and 20	20	+.0125
13 and 19	17	+.0034
14 and 18	16	−.0034
15 and 17	11	—.0034
Total,	817	.3708

We have neglected the sixteenth experiment, because we cannot employ it without using some other experiment twice, thus giving the latter an undue influence; and because the middle term should have the least weight in determining the common difference.

By the above table, we find, as the combined result of all the experiments, that .3708 should be eight hundred and seventeen times the common difference; and hence the common difference for one degree of Fahr. is .0004538 inch. Now, assuming 94.05 inches, as the mean length of the granite, which is sufficiently near, we find the linear expansion for one inch of stone for each degree of Fahr. to be $\frac{.0004538}{94.05} = .000004825$ inch, and for one foot, this expansion would be .0000579 of an inch. By proceeding in the same way with the experiments on the other stones, we obtain the following results.

Mean whole length in inches.		Common difference in inches for the whole length of stone for 1° of Fahr.	Common difference in inches, for one inch for each degree of Fahr.
Granite,	94.05	.0004538	.000004825
Marble,	93.44	.0005297	.000005668
Sandstone,	94.05	.0008965	.000009532
White pine,		- - -	.00000255
Hammered copper,		- - -	.00000944

To apply these results to the case in question, let us suppose two coping stones of five running feet each, to be laid in mid-summer, when they have a temperature of ninety six degrees Fahr.; in winter their temperature may safely be assumed at zero, so that the total variation of temperature will be ninety six degrees; and if we suppose these stones to contract towards their centers, which would be the most favorable supposition as regards the tightness of the joints where a number of these stones are used, the whole length of stone put in motion by a change of temperature would be five feet. If the coping be of granite, the distance by which the ends of the stones would be separated, in consequence of *one* degree's variation would be sixty inches multiplied into .000004825=.0002895 and for a variation of ninety six degrees, this distance becomes .0002895×96=.027792 inch, giving a crack a little wider than the thickness of common pasteboard. For marble this crack would have a width of .03264, nearly twice the thickness of common pasteboard; and for sandstone .054914, nearly three times the thickness of pasteboard. These cracks are not only distinctly visible, but they allow water to pass freely into the heart of the wall. The mischief does not stop here: by this constant, motion back and forth in the coping, the cement, of whatever kind the joints might be made, would be crushed to powder, and in a short time be totally washed by the rains from its place, leaving the whole joint open.

Art. XV.—*On two new acid compounds of Chlorine, Carbon, and Hydrogen; by* Augustus A. Hayes.

Among the compounds which result from the action of chlorine on alcohol, there are two, whose relations to bases are such as to entitle them to be classed with those acid combinations, in which hydro-carbon neutralizes, in part, the properties of the other proximate element. When pure alcohol at 32° F. is exposed to a current of chlorine, which has passed through a refrigerated tube in part filled with fragments of dry lime, there is an absorption of the gas, and unless suitable baths are used, an elevation of temperature is occasioned; the rapidity of the current being diminished, a small quantity of alcohol will continue to absorb it for several hours. The liquid becomes of a greenish yellow color and, unless the agitation has been considerable, consists of two portions of different densities, the lighter, containing more alcohol and less acid than the denser: both are lighter than water. If the operation is continued, globules of chloric ether mixed with other compounds, will separate and occupy a lower place. On diluting the mixture with water, a separation of more chloric ether takes place, other globules appear and are volatilized, with the odor of muriatic ether, as the temperature rises; much muriatic acid and alcohol are also present. After decanting the fluid from the chloric ether and mixing it with hydrate of lime, it loses its acid suffocating odor and diffuses the grateful odor of chloric ether. Distilled into a cooled receiver, some chloric ether dissolved in alcohol is obtained. The remainder consists principally of muriate of lime, but contains two salts which are simultaneously formed, and which may be obtained by evaporation, and separated by crystallization. Results differing from these are under other circumstances obtained, and will be hereafter described. When we substitute for the gas, a chloride of an alkaline oxide, less complicated changes occur. We may use with advantage, the mixture of hydrate and chloride of lime constituting bleaching powder. The best bleaching powder, in the market, contains $\frac{30}{100}$ of condensed chlorine. If we add to such powder, contained in a flask, its weight of ordinary alcohol, on mixing, the mass emits very acrid penetrating vapors, consisting of chloric ether mixed with one of the new acid compounds: the temperature gradually rises, and if more than ten or twelve ounces of the powder are used, violent ebullition succeeds and the products are varied: if by cooling the vessel, or using several small vessels, a slight elevation of temperature only is produced, the alcohol is absorbed and after twenty four or thirty hours, a consistent mass, having some chloric ether and alcohol mixed with it remains. This mass treated with its bulk of warm water, affords a solution of the saline part, and the washings of the lime being mixed with it and evaporated, till a saline pellicle forms, the salts crystallize on cooling. The crystals separated from the fluid by a thin cotton filter and pressed, will readily dissolve in a small quantity of distilled water, a few grains of carbonate of lead being added and the fluid boiled, excess of lime is removed, the clear solution by evaporation, will afford saline pellicles, which may be removed as they form, and when dense, the solution will give much salt in acicular, prismatic crystals on cooling. By repeating the operations of crystallization, the two salts can be separated with considerable accuracy: the minute quantity of the more soluble salt, may be entirely detached from the other, by washing it in two bulks of alcohol. These salts are neutral and consist of distinct acids united to lime. The acid which exists in the less soluble salt, I have named *chlorovinic*, its characters being the most diverse from the hydro-chloric, and to the other have applied the appellative *chlorovinous.*

Chlorovinate of lime, when obtained from solutions containing traces of alcohol, is in the form of rectangular tabular crystals, much disposed to group and form radiated masses; it possesses a pearly lustre, is translucent and of a light yellow color, the crystals have the tenacity so apparent in ferro-prussiate of potash. At 212° F. exposed to dry air, it loses no water, nor is the interior arrangement of the crystals altered; they are, therefore, anhydrous. When heated in a tube at 300° to 400° F., it becomes brown, a fluid forms, which gives to the mass the appearance of fusion: the vapor is dense and colorless, readily condenses in water, and is nearly pure chlorovinous acid: a dark gray, dry residue of chloride of calcium and carbon, remains. In water it dissolves and affords a dense, colorless solution, which, at the point of ebullition, dissolves but little more salt; it dissolves slowly in alcohol, and its hot saturated solution does not deposit crystals on cooling. Its aqueous solution gives with pro-nitrate of mercury, a salt of moderate solubility, but does not occasion any precipitate, or cloudiness, in solutions of nitrate of silver, nitrate of lead and nitrate of copper. Oxalic acid, precipitates a white oxalate of lime and detaches the acid.

Chlorovinite of lime is in the form of hexagonal prisms, generally truncated, but sometimes pyramidically terminated: colorless and transparent, brittle, cross fracture even, permanent in the atmosphere and unaltered by light. In dry air the crystals become opake and finally fall to powder; warmed, they give off pure water; heated, they swell, emit gas, char and at near the temperature of melting glass, a gray fused mass, composed of chloride of calcium, carbonate of lime and carbon remains. In pure alcohol, they lose water and slowly dissolve; a hot saturated solution, deposits crystals on cooling. In water it is very soluble; its solution dissolves much salt when heated and deposits crystals on cooling. Its solution when added to a solution of nitrate of silver, causes the precipitation of dense curdy white flocks; in nitrate of lead, no precipitate, or cloudiness appears, even if the solutions are concentrated, or heated; with pro-nitrate of mercury, there is a white precipitate which becomes crystalline, and is partially soluble in water. With solutions of copper, chlorides of sodium, barium and potassium, the resulting salts are soluble. Oxalic acid eliminates the acid and forms a white oxalate of lime.

(To be continued.)

Art. XVI.—*On a disturbance of the Earth's magnetism, in connexion with the appearance of an Aurora Borealis, as observed at Albany, April 19th,* 1831; by Joseph Henry, of the Albany Academy.

[Communicated to the Albany Institute,* January 26, 1832.]

That the aurora has some connexion with the magnetism of the earth, was asserted as early as the middle of the last century; and since that time, many observations have been recorded, tending to confirm this position. 1. It has been observed, that when the aurora appears near the northern horizon in the form of an arch, the middle of this is not in the direction of the true north, but in that of the magnetic needle at the place of observation; and that when the arch rises towards the zenith, it constantly crosses the heavens at right angles, not to the true, but to the magnetic meridian. This fact is most obvious where the variation of the needle is great.

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* And forwarded for insertion in this Journal.

2. When the beams of the aurora shoot up so as to pass the zenith, which is sometimes the case, the point of their convergence is in the direction of the prolongation of the dipping needle at the place of observation. 3. It has also been observed, that during the appearance of an active and brilliant aurora, the magnetic needle often becomes restless, varies sometimes several degrees, and does not resume its former position until after several hours.

From the above facts, it has been generally inferred that the aurora is in some way connected with the magnetism of the earth; and that the simultaneous appearance of the meteor, and the disturbance of the needle, are either related as cause and effect, or as the common result of some more general and unknown cause.

The subject is, however, involved in much obscurity; and there are some facts which tend to throw doubt on the connexion of the two phenomena. The accurate and valuable observations of Col. Beaufoy in England, continued for several years, add nothing towards establishing the fact of the magnetic influence of the aurora; and in the scientific expeditions under Capt. Parry, to the north, in the peculiar regions, as it would appear, of this meteor, no unusual disturbance of the needle was observed to accompany the aurora, although the apparatus was visited every hour in the day, and sometimes oftener, when any thing rendered it desirable. Indeed, so far from producing a disturbing effect, Dr. Brewster concludes, from a comparison of the observations, that the aurora, in the arctic regions, seems rather to exercise a sedative influence.*

On the other hand, Dr. Richardson states, from his own observations, made at Bear Lake, during six successive months of the years, 1825–6, and again in 1826–7, that the aurora does influence the magnetic needle. "A careful review of the daily register," says he, "has led me to form the following conclusion: That brilliant and active coruscations cause a deflection of the needle almost invariably, if they appear through a foggy atmosphere, and if prismatic colors are exhibited; on the contrary, when the atmosphere is clear, and the aurora presents a dense steady light of a yellow color, and without motion, the needle is often unaffected."†

In this state of knowledge, every additional fact becomes of some importance. The following communication, it is therefore hoped,

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* Edinburgh Philosophical Journal of Science, vol. 8.

† Edinburgh New Philosophical Journal, vol. 5.

may be useful, either in directing the attention of observers in this country to the subject, or in corroborating similar observations made in other quarters of the globe.

In September, 1830, I commenced a series of observations, for Professor Renwick, of Columbia College, to determine the magnetic intensity at Albany. In the course of these, I unexpectedly witnessed a disturbance of the magnetism of the earth, in connexion with an appearance of an aurora, which on some accounts appears interesting.

The needles used in these observations, were those mentioned in Capt. Sabine's letter to Prof. Renwick, published in the 17th volume of the American Journal of Science. One of these, it will be recollected, formerly belonged to Prof. Hansteen of Norway, and the other to Capt. Sabine. They were suspended, according to the method of Hansteen, in a small mahogany box, by a single fibre of raw silk. The box was furnished with a glass cover, and had a graduated arc of ivory on the bottom, to mark the amplitude of the vibrations. It had also two small circular windows, diametrically opposite to each other, through which the oscillations of the needle could be seen.

In using this apparatus, the time of three hundred vibrations was noted by a quarter second watch, well regulated to mean time; a register being made at the end of every tenth vibration, and a mean deduced from the whole, taken as the true time of the three hundred vibrations. Experiments carefully made with this apparatus, were found susceptible of considerable accuracy; as the individual observations, after a small correction for temperature, give a result, except in a few instances, differing from the mean of a number made under similar circumstances, by a quantity not greater than one part in nearly a thousand.

The observations were repeated daily, when the weather would permit, from the latter part of September to the last of November, either at the hours of 12 at noon, or between 5 and 6 P. M.* I was always assisted in making them by the same person, my relative, Mr. Stephen Alexander, to whose skill and experience I am much indebted for any accuracy they may possess.

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* These times were chosen only on account of being most convenient.

In April, 1831, a new series was commenced, to determine if the needles still indicated the same degree of magnetic intensity. No material difference was observed, except in the following instance, when a remarkable anomaly was exhibited.

On the 19th of April, at 12 o'clock at noon, an observation was made with the Hansteen needle, the result of which differed only the fractional part of a second from the usual mean rate of this needle. At 6 o'clock P. M. the same day, another observation was made with the same needle, and apparently under the same circumstances; but a remarkable change was now observed in the time of its making three hundred vibrations, indicating a great increase in the magnetic intensity of the earth. It was at first supposed that the needle had accidentally been placed contiguous to some ferruginous substance; but on a most careful investigation, nothing could be discovered which would tend in the least degree to explain the cause of the phenomenon. The experiment was made at the usual place, with the box containing the needle resting on a post permanently fixed for the purpose, in the Academy Park, at a sufficient distance from every disturbing object, and with the usual precaution of divesting the person of all articles of iron, such as keys, knives, &c.

At about 9 o'clock in the evening, or three hours after the above observation, an unusual appearance was noticed in the *southern* part of the heavens, which was shortly afterwards recognized as an arch of the aurora. It was about nine degrees in breadth, with the vertex of the arch twenty degrees above the horizon. At this time the northern part of the sky was covered with light fleecy clouds. At forty five minutes past nine, the clouds partially disappeared, and disclosed the whole northern hemisphere entirely occupied with coruscations of the aurora, shooting up past the zenith, and apparently all converging to the same point. The actual formation of a *corona* might probably have been observed, but for a dark cloud which remained stationary a little south of the zenith. The idea for the first time now occurred to me, that this uncommonly brilliant appearance of the aurora might possibly be connected with the magnetic disturbance observed at 6 o'clock; and in order to test this, the apparatus was again placed on the post in the Academy Park, and an observation made during the most active appearance of the meteor.

The result of the observation was, however, entirely different from that anticipated; for *instead of still indicating, as at* 6 *o'clock, an uncommonly high degree of magnetic intensity, it now showed an intensity considerable lower than usual.*

Observations were also made on the 20th and 21st, but no disturbance was again noticed; the intensity had resumed its former state.

The following table exhibits the observed times of three hundred vibrations, with the mean temperature and aspect of the weather during each observation:

DAY.	Time of 300 vibrations.	Mean temperature.	Weather.
April 19th, 12 h. noon.	980″.75	$66\frac{1}{2}°$	Cloudy, rain A. M.
" 19th, 6 h. p. m.	968″.65	61°	Clear.
" 19th, 10 h. p. m.	982″.20	52°	Broken clouds.
" 20th, 6 h. p. m.	978″.68	$51\frac{1}{2}°$	Clear.

The above observations may be reduced approximately to the uniform temperature of 60°, by the formula,

$$T=T'\,[1\pm0.000165(t'\pm t)],\ *$$

(T being time, t temperature in degrees of Fahrenheit,) which was deduced from experiments on a similar needle. The relative intensities may also be readily calculated, since they are reciprocally as the squares of the times of the vibrations. In this way, by assuming as unity the time observed on the 20th, we have the following results:

DAY.	Time of 300 vibrations at temperature of 60.	Relative intensities.
April 19th, 12 h. noon.	979″.94	1.00022
" 19th, 6 h. p. m.	968″.49	1.02401
" 19th, 10 h. p. m.	983″.50	0.99299
" 20th, 6 h. p. m.	980″.05	1.00000

From the mean of several observations made with this needle in April, I consider its time of three hundred vibrations for this month, and in an undisturbed state of terrestrial magnetic intensity, to be nine hundred and seventy nine seconds. The accidental errors in the above observations do not probably exceed, in any case one second.

At the time of registering the above observations, I had not seen the following remark of Prof. Hansteen, which was subsequently met with in the 12th volume of the Edinburgh Philosophical Journal:—"A short time before the aurora borealis appears," says Prof. Hansteen, "the intensity of the magnetism of the earth is apt to rise to an uncommon height; but so soon as the aurora begins, in proportion as its force increases, the intensity of the mag-

* This formula was obtained by Hansteen.

netism of the earth decreases, recovering its former strength by degrees, often not till the end of twenty-four hours."* This statement, founded on observations made in Norway, is a precise description of the phenomenon observed in Albany; and should it be found a general, or even a frequent occurrence, that a great increase of intensity precedes the appearance of the aurora, it would perhaps reconcile many apparent discrepancies in the different accounts of magnetic influence of the meteor.

Prof. Hansteen also remarks, in the same paper, that "the polar lights seem to be the effect of an uncommonly high magnetic intensity, which lets itself off, as it were, by the aurora, and thus sinks under its common strength." Nothing, however, can with certainty be deduced from these observations, in reference to this supposition; since the magnetic intensity at any place, as exhibited by the vibrations of the horizontal needle, may change while the absolute force or intensity of the whole earth remains the same. If we present by F the whole force in the direction of the dipping needle, by δ the dip in degrees, and by H the horizontal force, we shall have, by a well known law,

$$F = \frac{H}{\text{cosin } \delta}.$$

In this formula it is evident that F may remain constant, although H is caused to vary by a change in the value of *cosin* δ. The fact, therefore, of a variation in the absolute intensity, can only be determined by combining the observations of the vibrations of the horizontal needle with simultaneous observations on the dipping needle.

If we suppose F constant during the change of horizontal intensity as observed at Albany, we may, by means of the above formula, calculate the change in declination or dip required to produce the observed difference in the horizontal intensity. Assuming $\delta = 75°$, (the dip at Albany nearly,) and H = to the horizontal intensity observed at 6 o'clock, we can readily find the value of F; and since this value is supposed constant, by substituting it in the expression

$$\text{cosin } \delta = \frac{H'}{F}.$$

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* I find the same observation has also been made by Humboldt; and also a similar one by Van Swinden, who remarks, that the variation of the needle increases when the aurora borealis is approaching. Journal Royal Institution. Young's Natural Philosophy, vol. 2, p. 442.

in which H′ represented the intensity observed at 10 o'clock, we shall have the value of δ (the dip) corresponding to the latter intensity. In this way, the change observed in the horizontal intensity at the time of the aurora, gives 28′ 48″ as the deviation of the needle in the plane of the dip.

The aurora which appeared in connexion with this magnetic disturbance, was probably one of the most interesting ever observed in this country, particularly from the circumstance of the actual formation of a *corona*, which was seen in several parts of this State. My friend Prof. Joslin, of Union College, who happened to be in New York at the time, has furnished me with the following account:

"The aurora borealis of 19th April, as it appeared in the city of New York at 9 P. M., was peculiarly interesting, on account of the meeting of the luminous columns in the magnetic meridian, at the point in the direction of the dipping needle towards which they usually tend. The luminous matter occupied the whole northern half of the visible celestial hemisphere, and was very much condensed near the point of convergence. Some of the eastern coruscations were at times transiently curved, as though their middle parts (as was probably the case) were driven eastward by the impulse of the westerly breeze which was blowing at the time. A luminous band was at one time extended across the heavens, at right angles to the meridian, and 30° south of the zenith. This had at times an oscillatory motion in a north and south direction. It passed near the moon, around which was one of the large halos. The sky had been previously clear. The converging rays appeared to meet at the star δ Leonis."

By computing the position of δ Leonis for 9 o'clock on the evening of the 19th, its altitude was found to be 70° 25′, and it azimuth 11° 27′ east. A small error in time, however, would make a great difference in the azimuth. The dip of the needle at New York is 73°, and the variation probably between 4° and 5°, as it is 6¾° at Albany.

The aurora was also seen by Dr. William Campbell, at Cherry Valley. He describes it as very brilliant, and assuming a variety of forms; at one time appearing as a stupendous arch, crossing the heavens from east to west; at another, radiating from a point south of the zenith. The Rev. Mr. Thummel, of the Hartwick Seminary, at his residence in Otsego county, likewise observed the same aurora. He describes it as radiating in every direction from a nucleus near the zenith, which appeared clear and compact for some time, when it began to move, and darted forth rays in every direction like crystals.

March 6, 1832.

Since the foregoing was communicated to the Institute, several particulars have been learned in reference to the subject, which, on some accounts, are deemed interesting. The Annual Meteorological Reports of the different Academies in the State of New York, to the Regents of the University, have been received; and from them it appears that the aurora of the 19th of April was visible over the whole extent of the State, and probably considerably west of it. It is described as being very brilliant at Lewiston on the Niagara river, extending high, and farther to the south than any before observed. In the eastern part of the State, it was seen at most of the Academies along the Hudson, and at Erasmus Hall on Long Island. It also appeared brilliant at Potsdam in St. Lawrence county, the most northern Academy in the State. It was probably not seen very extensively in the States east of New York, as I am informed the weather in the eastern part of New England was cloudy at the time, accompanied with rain. The aurora is described as shooting up to the zenith at North Salem; and at Middlebury as consisting of coruscations in almost every part of the visible heavens. At Fairfield, it illuminated nearly the whole heavens; a number of bows, commencing in the northwest, passed south of the zenith, and terminated in the northeast. An interesting account is given of its appearance at Utica, where it is described as rising at one time in streams of light, of purple, yellow, green and other colors, and exhibiting a rapid horizontal motion, passing and repassing like a company of dancers. The actual intersection of the beams so as to form the appearance called the *corona*, is mentioned as having been seen in the city of New York, at Hartwick, Cherry Valley, Hudson, and Prattsburgh in Steuben county.

The only plausible explanation of the formation of the *corona*, is that which supposes the beams of the aurora to consist of cylindrical portions of some kind of matter, which becomes luminous as it passes into the higher regions of the atmosphere; and that the cylindrical beams shoot up from many points of the earth's surface, nearly parallel to each other, and in the direction of the dipping needle. Being at different distances from the observer, they appear of different elevations; and sometimes, when seeming to overlap each other, they form continued streaks of light in every part of the visible heavens. The corona, according to this hypothesis, is the perspective projection on the sky, of the beams which are shooting up at the same instant on all sides of the observer, and which, being all parallel to the dipping needle, appear to converge as it were to a vanishing point, situated, in the State of New York, about 15° south of the zenith. If this hypothesis be correct, and it seems a strict geometrical deduction from actual appearances, it would follow, that on the evening of the 19th of April, beams of auroral matter, were shooting up from every part of the surface of the State of New York.

But the most interesting circumstance in reference to this aurora, is that which I have learned from the December number of the Journal of the Royal Institution of Great Britain, viz. the fact of a disturbance of terrestrial magnetism being observed by Mr. Christie in England, on the same evening, and at nearly the same time the disturbance was witnessed in Albany, and that too in connection with the appearance of an aurora.

Mr. Christie had adjusted a magnetic needle for the express purpose of observing the effect when an aurora should appear, but was not so fortunate as to be able to make any observations with it until the evening of the 19th of April. His apparatus consisted of a light needle six inches long, suspended within a compass box by a fine brass wire $\frac{1}{600}$ of an inch in diameter, and twenty three inches long. The needle was deflected from the magnetic meridian by the repulsive action of two bar magnets placed on opposite sides of it; so that, instead of pointing to the magnetic north, it settled in the direction of N. 37° W. As the needle assumed this position in consequence of the attractive force of the earth, and the repulsive force of the magnets, a deviation from the north towards the west would indicate a diminution of the terrestrial horizontal intensity, and a deviation towards the north an increase in that intensity, the intensity of the magnets remaining the same. At 10 o'clock P. M. on the evening of the 19th, during the appearance of the aurora, Mr. Christie found the needle vibrating between N. 43° 40′ W. and N. 42° 40′ W. At 10h. 15m. its direction was N. 34° W. It continued to approach the north until 10h. 37½m. when it pointed N. 33° 30′ W. It again receded from the pole, and at 10h. 40m. vibrated between N. 37° W. and N. 36° W. The next morning at 7h. 20m. the needle pointed N. 40° W. From this brief abstract of Mr. Christie's observations, it will be seen that the horizontal intensity was less than usual at 10 o'clock; that it increased until 10h. 37½m. when it was greater than in its undisturbed state; and that it again decreased, and was less than usual the next morning at 7h. 20m.

By adding five hours to the time of the observations made at Albany, we shall have nearly the corresponding time at Mr. Christie's residence in Woolwich. These times being 6h. and 10h. P. M. will therefore correspond with 11h. P. M. and 3h. A. M. of time at Woolwich. From this it appears, that the observations at Albany were made at a period of absolute time between the last observation of Mr. Christie on the evening of the 19th, and the morning of the 20th. The only interesting result, however, which apparently can be drawn from a comparison of the observations, is, that at both places there was a disturbance of terrestrial intensity at the same time; the intensity rising above and sinking below its usual state at each, although these changes did not occur in the same order at both places.

I am not aware that a simultaneous disturbance of terrestial magnetism, in connexion with an aurora, has ever before been noted at two places so distant from each other. Nor do I think the coincidence in this case in the least degree accidental. On the contrary, it appears to me highly probable that the disturbing cause was not only common to both places, but was also active at the same time in a great portion of the northern part of the globe. A brilliant aurora is by no means a local phenomenon. That of the 28th of August, 1827, was visible over nearly the whole of the northern States, in Canada, and also from some part of the Atlantic ocean. But what places the extensive and simultaneous appearance of the aurora in a more striking point of view than any in which it perhaps was ever before exhibited, is the comparison of the notices of the aurora given under the monthly meteorological reports in the Annals of Philosophy for 1830 and 1831, and the Reports of the Regents of the University of the state of New York for the same period. By inspecting these two publications, it will be seen, that from April 1830, to April 1831 inclusive, the aurora borealis was remarkably frequent and brilliant, both in Europe and in this country; and *that most of the auroras described in the Annals for this time, particularly the brilliant ones, were seen on the same evening in England and in the State of New York.*

The particular days on which the aurora appeared in England, are not mentioned in the Annals, except when the aurora, is considered on some accounts interesting. By comparing those which are thus noticed, with the Regents' Reports, the following results are obtained:

The first aurora mentioned in the Annals for 1830, occurred on the 19th of April. A particular description is given of its appearance in England, and also a notice of its being seen in Scotland. In the State of New-York, a brilliant aurora was extensively seen on the same evening. Accounts are given of it from Auburn, Cambridge, Canajoharie, Cayuga, Franklin, Hudson, Lansingburgh, Lowville, Oxford, Pompey, Rochester, Union, Cazenovia, and Utica.

The second aurora noticed in the Annals, is that of the 20th of August. An aurora was also seen in the State of New-York, at Lowville, Pompey, Cazenovia, and is particularly described as presenting an unusual appearance at Utica.

The next aurora which appeared worthy of a particular notice in the Annals, happened on the 7th of September; and the same evening an aurora was seen at Lewiston in Niagara county. On the 17th of the same month an aurora was also observed in England, and the same time at Pompey, St. Lawrence and Utica.

Under the report of the meteorology for the month of October, in the Annals, two auroras are described as appearing, one on the evening of the 5th, and the other on that of the 16th. These were both seen in the state of New-York, the first at Utica, and the second at Lowville.

Two auroras are particularly mentioned as appearing in England in November; but no corresponding ones are noticed in the Report of the Regents, as having been seen in the State of New-York.

In the meteorological reports for the month of December, in the Annals, there are five auroras mentioned. The most interesting of these happened on the 11th, and exhibited peculiar appearances. At one time, from a segment of the horizon of 70 degrees in extent, there emanated several flame-colored perpendicular columns, some of which were 2 degrees wide and 30 in altitude: these were succeeded by others, which ultimately exhibited red and purple tints. Many persons in England saw the aurora, and described it as exhibiting an awful appearance from a mixture of the colors. The most brilliant aurora which appeared in the State of New York during 1830, happened on the same evening. At Albany, it extended nearly 90 degrees around the northern horizon; and at one time, a row of bright columns rose from an arch, and extended upwards, some of them nearly to the north star. The columns from the western limb of the arch were slightly tinged with redness; all the others were white. At Lowville, flashes of light are described as arising from the north to the zenith, and thence descending half-way to the southern horizon. It was brilliant at Auburn, Dutchess, Erasmus Hall, Lansingburgh, Hartwick, Lewiston, North-Salem, Plattsburgh, Rochester, St. Lawrence, Union, and Utica. An aurora also appeared on the 12th of the same month, and a brilliant one was likewise seen in the State of New-York, at Auburn, Dutchess, Franklin, Fredonia, Ithaca, Lansingburgh, Lewiston, Middlebury, North-Salem, Plattsburgh, Pompey, St. Lawrence, Utica. Faint auroras are also mentioned as appearing in England on the 13th and 14th, and another on the evening of the 25th; but no corresponding ones are described in the Regents' Report.

In 1831, the first aurora described in the Annals, is that of the 7th of January,; "and of all the auroræ boreales," says the author, "that have been observed here (in England) the last twenty years, (some say forty,) this was the most extensive the most beautiful in colors, and the most interesting on account of the singular phenomena which it displayed, in the number of distinct luminous bows which were presented in the course of the night." Several communications are given on the subject of this aurora, in the Annals of Philosophy, and the Journal of the Royal Institution. It was seen at Paris, and at Brussels. A particular description is given of its appearance in Utrecht, by Prof. Moll. On inspecting the Reports for 1831, I find that an aurora was seen in the State of New-York, at places in the extreme east and west part of the State—at North-Salem on the east side of the Hudson river, and Fredonia near Lake Erie; and intermediate to these places, at Utica, and Pompey. The Annals also mention that faint auroras were seen on the evening preceding and following, and also an aurora on the 11th. An aurora was noticed at several places in New-York on the evening of the 6th, but none on that of the 8th or 11th.

No auroras are mentioned in the Annals under the meteorology for February, but three are noticed for March; the first, an interesting one, appeared on the 7th; the second on the 8th; and the third, a bright one, on the 11th. By referring to the Reports of the Regents, it will be seen that auroras were observed on the same evening in several places in the State of New-York.

The next aurora mentioned in the Annals, is that of the 19th of April, which has been the principal subject of this paper. An interesting account is given of its appearance in England, which states that at one time there was a grand display of about ten long active streamers along an arch of the aurora, several of which ascended to an altitude of sixty degrees ; and when most active, many passed beyond the zenith, exhibiting at the same time several prismatic colors. At 10 o'clock, the arch of the aurora extended 150 degrees. The extensive appearance of this aurora in the State of New-York, and the magnetic disturbance accompanying it, have already been sufficiently described.

The above coincidences appear too numerous to admit the supposition that they are merely accidental, particularly when it is recollected that there are many causes to prevent the cotemporaneous appearance of an aurora being recorded at two distant places, although it exists at both. While it is observed at one place, it may be obscured by clouds, or may escape the notice of the meteorological observer, at the other. Besides this, the coincidences occured on the evenings when the aurora was most brilliant, and consequently when its action might be supposed most extensive. These simultaneous appearances of the meteor in Europe and America would therefore seem to warrant the conclusion, that the aurora borealis cannot be classed among the ordinary local meteorological phenomena, but that it must be referred to some cause connected with the general physical principles of the globe; and that the more energetic actions of this cause, whatever it may be, affects simultaneously a great portion of the northern hemisphere.

MISCELLANIES.

(DOMESTIC AND FOREIGN.)

1. *Dr. Muse's Vindication of his paper, page* 71 *of this No.*

Remark.—In consequence of a communication by the Editor to Dr. Muse, of the opinion respecting the Hessian Fly, which is stated in a note at the end of his paper, he has transmitted the following remarks.

Fortunately, if I have erred in the identification of the Hessian Fly, the error cannot affect the chief object of my communication ;

because the fact of the very numerous *chrysalids* of the Hessian Fly, as stated by me and which I have too long known to mistake, and the incidents which gave rise to them and against which it was, in my opinion, necessary for the agriculturist to be guarded, formed my paramount motive.

Notwithstanding the authorities cited against me, I must still maintain the identity of the Hessian Fly with the insect which I faithfully and correctly described in the paper alluded to.

First. The sod of wheat, placed under the glass jar, was loaded with well known *chrysalids* of the Hessian Fly.

Secondly. In due time, swarms of the insect described by me appeared on the stalks and blades of the wheat within the jar, and having first several times cast off their exuviæ, made their deposits, which finally crawled down and attached themselves firmly, by piercing the plant with their probosces; and, throughout half the winter, there were many new developments, although I cannot say that these were, certainly, from recent deposits; they may have proceeded from the original chrysalids, of different ages when taken in.

Shortly after the appearance of this numerous brood, I discovered a few other flies, of the Diptera order: three of these were apparently impoverished, small, house flies; indeed, so distinctly marked as the Musca communis, that I had no difficulty on the subject, and concluded they were produced from deposits of this fly, made in the fall previous, on the rotten portion of the wheat, before I had taken it in.

About the same time appeared eight or ten others, also belonging to the order Diptera, and, as I believe, to the genus Culex; and but for their short, inflected probosces, would have called them musketoes, whose armature is too well known in Maryland to be mistaken: upon a closer investigation, they may be referred to the Tipula, whose habits and appearance strikingly resemble them, (the Culex.) They nidify and feed alike, on stagnant waters, rich damp earth, and mud. The origin of these, also, I referred to deposits, in the fall, on the rich earth containing my wheat in the jar, and I have still no doubt of the fact; and in this manner mistakes may have arisen on this subject.

The larvæ and chrysalids of the Tipula are uniformly found in such places as I have named, and not on living plants; and if the Hessian Fly be of this family, it is, I suspect, the only exception. The larvæ and chrysalids of the Hessian Fly, unquestionably known in those stages of its existence, are invariably found on living plants, and independently of the injury to vegetation, by the hard chrysalids interrupting the ascent of the sap, the larvæ obviously suck the juices of the plant for their food.

It is the habit of the whole genus Aphis, to which I have referred the fly in question, to feed in its larva state on tender succulent plants, and on such alone they nidify: this not being the habit of the Tipula, nor of the house fly, I did not hesitate on the identification; and the vast disproportion of numbers, taken in reference to the well known chrysalids, as stated by me, (there being only a few of the two latter and immense numbers of the Aphis, which was selected by me as the true parent,) no doubt was left on my mind, that the well known chrysalid of the Hessian Fly, in my sod of wheat, had developed neither the Musca, nor the Tipula, but the *Aphis*, to which I referred it.

In the truth of this opinion I am much strengthened by an intelligent and highly respectable neighbor, who frequently saw the flies in my jar: he declared the kind which I described in my paper, to be the identical kind which he the last summer had cut out from the flax seed casement of the Hessian Fly in the wheat field, when mature and prepared to escape from it; and that the other two kinds, the Diptera before named, were so wholly unlike those which he thus obtained, that he could not be deceived.

Upon investigation, I have discovered a great contrariety of opinion and testimony on the identity of the Hessian Fly, arising unquestionably from such circumstances as may possibly, also, have deceived me.

Mr. James Vaux, in a communication to a philosophical society, in 1792, on this subject, says he has frequently seen them [the Hessian Fly] in the act of depositing the egg, and that they resemble a "slender, gaunt, *house fly*."

Judge Buel, in a paper on this subject, in the American Farmer, compares them to a musketo, except that they are smaller, and have a short bill—certainly, the house fly and musketo have no similarity.

Some say, from personal observation, that they nidify upon the grain exclusively—others, with equal confidence and as I believe with more propriety, say exclusively upon the leaf and stalk; the parent fly has necessarily been mistaken.

Some affirm that they finish their nidification by the 20th of September: Dr. Chapman is of this opinion. Under my own observation, they have continued it, *destructively*, on wheat sown after the middle of November.

It follows, that this interesting subject remains yet in obscurity, perhaps in all respects; and its farther prosecution is more imperiously called for, by the absolute wants of the community, than that of any other to which natural science can be directed.

Cambridge, E. S. of Maryland, Feb. 26, 1832.

2. *On belts of evergreens, as skreens, for the garden, the orchard, vineyard, &c.**—The *temperature*, in winter, of *every* living vegetable,—that is, of some part of it, in which principally resides its vitality, during the season of its least activity,—is always *higher* than that of a *dead* vegetable, of the same kind, as is the case also with hybernating animals, in their season of torpidity. The natural temperatures of living things vary, according to their kinds and habitudes. *Trees*, of the class of *evergreens*, in perpetual verdure, constitutionally adapted to life in colder regions, have a *higher temperature of vitality*, than *deciduous trees*. The same sunshine, which, in winter, falls upon the leaves and the leaf-covered branches of an evergreen, and upon the leafless branches of the oak or other deciduous tree, produces widely different effects. As if there were a repulsion between cold and heat, the ascending blaze of a fire cannot be made to come into contact with the bottom of a tea-kettle or boiler, filled with cold water; but will do so when heated up to near boiling, coming nearer and nearer as the temperature of the water is raised.

My supposition is, that the effect of the sun beams is always in proportion to the temperature of the thing on which they fall. If, for example, the sun beams, in winter, fall on a living and a dead human body, I suppose that the living would imbibe more solar heat than the dead. Also, that when the temperature of the open air is at zero and that of a hot bed at 60°, for example, its glazed covering open to the sun—that the rays of the same sun would increase the temperature of the hot bed more than that of the open air; or, that when the temperature of the open air is at zero, and that of a dwelling room, open to the south by a window, is at 60°, indicated by accurate thermometers, both in the shade; that on letting the rays of the sun fall on each, the rise will be greatest in that

* This paper was written as part of a series entitled the *Country Farmer*, and would have been No. XXIII of a series now in the course of publication in another journal.

one which indicated the most heat. This, however, in these cases, cited to make my meaning clear, is theory only, for I never have tried the experiment, although so perfectly easy of trial.* As to the effect on pine leaves and the tea-kettle, I speak from experience and repeated observation. So, also, as to what is assumed of the different degrees of temperature of *living* and *dead vegetable roots*, in my last No., a reference to which will show the bearing of these remarks upon the true philosophy of scientific agriculture. While the dead branches of the limbs and twigs of the pine tree of the same grove, are seen covered with the ice and the snow of winter, long after its storms, those of the living tree, and its leaves, are as free as in summer. They are even giving out their caloric to the atmosphere, like deep water attempering its severity of cold; while the deciduous trees, from the power of extreme cold, are splitting from their centres, with loud reports, like signal guns.

Where is the farmer, with a grove of evergreens near him, accessible to the "locomotives" of his barn-yard, who has not seen with what avidity they retire to its friendly shelter, in winter, and with what reluctance they leave it, even after having finished the chewing of the cud, while wanting a new supply for their ruminating functions? And where is the farm, on which this luxury has been procured, by human effort? From necessity, our fathers cut down our groves, and too long perseverance in the first habit of every new country, has made us wasteful in the extreme. For where, also, is the farm, of twenty, thirty or fifty years old, on some one or many of the fields of which, it would not now be desirable to have the destroyed groves of wood restored, either as skreens from the wind, for use as timber, or for ornament? I know of no one, from cold and bleak New England to Georgia, or from the Atlantic to the Ohio.

The common opinion seems to be, that groves of evergreens are in winter, warmer than those of deciduous trees, only by the greater obstruction they afford to the currents of the air, in winds and storms. Hence so little use has been made of them, either as artificial skreens for the live stock of the farm-yard and the barn, or as a protection for fruit trees, and the orchard, and the garden. I once commenced an experiment of this sort, upon a new farm, by a circular belt of

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* The author's views require to be verified by careful experiments, made under circumstances excluding the influence of extraneous causes.

evergreens, on the north of a farm-house, barn, garden, vineyard and orchards, extending around from the north east to the south west; but it failed, by defect of title to the land. Late in the December of life, I reluctantly abandon the hope of such an experiment, but after stating my reasons for the hope of success, I thus invite public attention to a due examination of the whole matter. Fruit trees and vines, I know by experience, may thus be skreened from the peltings of the merciless storm and cold, and enjoy a climate, (if I may so say, a local climate,) strangely foreign to the place in which it is produced, and not less strangely congenial to the life and habits of the cultivated products. The live stock of the farm, and the wild game of the forests, choose their haunts with unerring wisdom, according to the seasons, and the heat, and the cold; of the knowledge of which the experienced huntsman, not disdaining to learn from untalking animals, avails himself, now searching the groves of evergreens, or the open woods, or the hill, or dale, as experience shall have taught him. But the hunter is half a savage! Man, civilized, learned, social and communicative, seems less inclined to take lessons from things, than from words, and thus goes on in blind habit; the progress of nations in philosophy seems to be the more tardy, as their advance in literature is more rapid.

Gentlemen of science and fortune, by entering spiritedly into improvements themselves, may do much towards giving new and rightful impulses to the public mind, in every thing connected with agriculture, and the arts and sciences. Some indications of this sort are occasionally to be met with, in various parts of our widely extended country, affording auspicious hopes, yet by far too circumscribed in the sphere of their influence. One reason of this is, that we are, as a people, not yet sufficiently aware of the power, in such matters, of a well conducted medium of communication, by the agency of the press, of which we are too parsimonious in our patronage. In England, the matter-of-fact discussions of the *public press*, in relation to *steam navigation*, *canals* and *rail roads*, bringing philosophy and science into the actual every-day business of life, have done more, in a few years, towards enlightening the public mind, than many ages of folio and quarto book making.

The county of Saratoga, New York, has been most profusely denuded, as Dr. Johnson would say, of its wood. In passing along its roads last summer, within a few miles of its celebrated mineral springs, there the extreme want of groves of wood, and evidence of the facility with which they might, with a little care, be supplied, were almost every where observable. Little copses, say of the white pine, along the road side, on farms almost naked every where else, had their branches and leaves almost lying on the ground, forming a thicket through which a bird could hardly fly, and a green wall of foliage from twenty to fifty or more feet in height. With such models before their eyes, supremely beautiful, a perfectly natural growth, I know not how it can have escaped these people, to provide such belts of evergreens, as skreens for their orchards, gardens, barn and farm-yards! They would be singularly beautiful and ornamental, besides being of much use, as well to each farm, as by providing *stopping places* for the winds, thus beautifying and benefiting the whole country, by an amelioration of its climate. In its primitive state, this sandy region whose surface is elegantly diversified, was covered with pines of gigantic stature. With plantations of the oak, chesnut, &c. which would grow rapidly, and some belts of evergreens, as above proposed, both of which are much wanted, these sandy plains and knolls would become again delightful. They have now an aspect of dreariness, which could soon be remedied by correct taste and spirited effort. There are many farms which would be beautiful except for these very features of *unbeautiful nakedness*; some of the proprietors are spirited improvers, on whom I hope these suggestions will not be thrown away.

HORATIO GATES SPAFFORD.

Dec. 31, 1831.

3. *Spontaneous Combustion.*

TO THE EDITOR.—*Sir*—A very novel case of *spontaneous combustion*, (novel at least to me,) which has recently occurred under my own observation, seems to merit a passing notice, by way of precaution to others; and it is the more alarming, and therefore the more entitled to attention, by reason of the increasing use of cotton in carpeting and floor cloths. The facts are submitted to your own discretion, as a Journalist in science and the arts.

We have, in our family-room, adjoining the kitchen, a Philadelphia cooking stove, in which, when the weather is cold and the price of fuel is high, some little culinary processes are at times carried on.

For this winter, the floor has been covered with some cheap domestic carpeting. The stove stands on the carpet, which being tacked down, and covered in places with oil cloths, has not been taken up during the winter. Of course, some grease spots had appeared contiguous to a side door of the stove, but they had been scoured off so as hardly to be discernible on the upper surface.

Some weeks ago, about noon, I was writing in this apartment, and having in charge two little children, the oldest one called my attention to the smoke which then filled the room. My first impression was that the house was on fire, probably in the kitchen; but on opening the door, first of that room and then of the parlor, no smoke was perceived in either, and I closed those doors, and began to search more narrowly. On looking at the carpet, I could see the smoke rising through it every where. I then looked into the cellar, found no smoke there, and closed the door, to prevent too free an ingress of air, and the bursting into flame. The carpet was then carefully examined by the eye and the hand, and one spot was found, and only one, where there was heat enough to make smoke. That spot was on one side of the stove, more than two feet distant from it, and the carpet was whole, though warmed but not hot, for I could bear my hand on it. I applied some snow to it, and found a browned spot of about two inches in diameter, which soon became a hole of that size, corresponding with one in the white pine floor-plank, underneath, which was browned and charred, not burned, less than half way through the plank. This occurred in a seam of the floor, where the planks were joined and in what had been one of the spots of grease: whether in contact with a nail, I have not yet ascertained. This is clearly an alarming case of *inceptive spontaneous combustion.* The carpet, the materials of which had, till now, escaped observation was found to be made of cotton, and flax tow, with streaks of woolen yarn filling, none of which, however, came within the charred hole above described. In the hope to guard others against similar dangers, these facts are communicated.

Very respectfully, your obedient servant,
HORATIO GATES SPAFFORD.

Lansingburgh, N. Y., February 27, 1832.—76.

Remarks.—The above statement of facts deserves particular attention, because the case is evidently of the same class with others that have been often reported. We refer, particularly, to the spontaneous combustion of fibrous vegetable stuffs, flax or linen, hemp and cotton, when imbued with oils, grease or tallow, and more especially with the drying oils; they become gradually heated, and, if in contact with the atmosphere, they are sometimes inflamed. The danger is supposed to be augmented when the drying oils are mixed with the metallic oxides, which are used as paints; the oxygen in them may aid in producing the combustion. The caution which ought to be observed is obvious: the fibres of the cotton, in the present instance having been more or less charged with grease or animal oil, were brought to a burning state by the gradual heat of the stove, which, at the distance of two feet and upon the floor, was probably not intense.

If, as we have been told, cotton is sometimes used as the basis of oil cloths, the latter ought not to be exposed to much heat, and it might be well not to lay them in great heaps in the ware houses, as even the heat of summer, or in winter of air warmed by stoves, might possibly cause a combustion.—*Ed.*

4. *Preparation of chloric ether:* A. A. Hayes.—In reply to the question respecting the preparation of chloric ether, in the last number of this Journal, I will describe the method which was sometime since adopted, for furnishing the preparation in considerable quantity. From marketable bleaching powder, such was selected as was least bulky, and the quantity of chlorine, per cent., ascertained by analysis. A weighed quantity was placed in a retort, and alcohol of sp. gr. .850, equal to the weight of the chlorine contained in the powder, was added. By agitating the mass and allowing it to remain a few minutes, a mixture tolerably uniform was obtained. The receiver, containing a quantity of water, was then loosely connected with the retort, in such a manner as to allow the beak of the retort to dip two or three inches into the water, and was refrigerated by a bath of snow and water. Heat was applied to the retort by means of a water bath, and when a part of the mixture had become heated to 150° F. distillation commenced; the water bath was then removed, the action of the materials being sufficiently energetic to maintain the temperature for some time: the water bath being subsequently applied, the operation was discontinued when ether ceased to be condensed. The fluids in the receiver consisted of a quantity of ether equal to one twelfth part of the weight of the alcohol used, a diluted spiritous solution of the

ether, and an acid compound of chlorine, carbon and hydrogen. The fluids were drawn from the ether,—which, by subsequent washing in cold water, was rendered perfectly pure,—neutralized by hydrate of lime and subjected to distillation, a portion of an alcoholic solution of ether was condensed in the receiver, and the remaining liquor, by evaporation, afforded a small quantity of a salt in prismatic crystals.

When the bleaching powder contains more than one quarter of its weight of chlorine, it is proper to diminish the relative proportion, by adding sufficient water and in condensing the ether, which is rapidly formed, ample refrigerating baths should be used.

5. *Bees.—A notice by E. Burgess, assistant in the Amherst Academy.*—Our bees were put into the ground, near the first days of November. A hole was dug on a dry spot of ground, large enough to take in one half or two thirds of the hive. Straw was then put around it as tight and close as possible; it was then covered with dirt, to prevent either the water or frost from penetrating to it. The hive was taken out during the first days of April, and the very moment the hive was reached, the bees seemed to be as lively and active as if they had been exposed to the warmth of a sunny day, although it seemed impossible, that the external heat could have penetrated as deep as they were buried, so as materially to alter the temperature. They went immediately to work with seemingly more animation, than those which had remained above the ground during the winter. The precise quantity of honey consumed is not known; but it could not have been more than half of the quantity consumed by swarms wintered the usual way.

Mr. P. a near neighbor put two swarms into the ground—but one of them lived. This hive contained only four pounds of honey —which is not more than one sixth or one fifth of the quantity required to winter a swarm the usual way. The swarm which died, was put into a potatoe hole—the potatoes became moist—from hence the bees became so and died. From this we infer that they should be buried so as to be kept perfectly dry, but whether it is absolutely necessary that they should be placed beyond the reach of frost, we have yet to learn from experiment. Mr. P. of New York buried the last winter six or seven swarms, and nearly all came out well—although being taken out quite early, one or two of them died before they were able to obtain any support from the field. None of them had nearly enough honey to have wintered in the common way, and it has been asserted that a swarm was wintered in that neighborhood, in which the diminution of the stock of honey could hardly be perceptible; and from the experiments that can be depended on, it seems fairly inferable, that it requires but a very small quantity to sustain swarms during the winter.

It is not known certainly what first led to this discovery—although it is reported that a man having a small swarm of bees with but very little honey, threw them into a potatoe hole and covered them up with the potatoes and with scarcely any design whatever, but in the spring was surprised to find his bees alive. On taking them out, they immediately went to work, and did better through the season than his other bees.—*Communicated by Prof. Hitchcock.*

6. *Trilobites.*—These curious relics, which Linnæus called *Entomolithi paradoxi*, were not understood before Brongniart had presented his views under the "Natural History of Crustaceous Fossils." Since that time, considerable attention has been devoted to them. Dr. De Kay, Dr. Bigsby, and some others, have examined them in this country with success. I shall not attempt any thing more in this fragment, than to call the attention of our naturalists to one mark of distinction, which seems to form an important dividing characteristic among them. I have even attempted a distinct genus to be founded upon it; and thus name and define it.

Brongniartia.—Fore abdomen always, and post abdomen in most cases, longitudinally divided into three lobes by regular series of *undulations*, traversing the joints, *without grooves:* articulations of the side lobes being manifest continuations of those of the middle lobe, and consequently, agreeing in number.

Dr. De Kay supposes that his Isotelus, and Dr. Bigsby's T. platycephalus, may form the type of a new genus. This he infers from general habit. I have received from Dr. Smith, of Lockport, two very fine specimens of Dr. Bigsby's species. The series of undulations and absence of grooves characterize both. M. Brongniart uses this expression as applicable to all the trilobites known to him—*par deux sillons profonds*, (by two deep furrows.)*

Taking these two species as the type, I have added a third, which is found in great numbers on the south side of the Mohawk river, east of Little Falls, on the Erie canal. This I published under the name

* See Nat. Hist. Tri. page 3.

Cancer triloboides in this Journal, Vol. XXI, p. 137. That name is strictly appropriate; but, it being referable to the same genus with the two species just named, I prefer labelling it, in my own collection, Brongniartia carcinodea.* I sent specimens of this species to M. Brongniart about eighteen months since. He remarked to the bearer, that this species seemed to form the connecting link between the fossil trilobite and living crab.

I have now before me a specimen of what appears to be a living trilobite, collected on the beach at Cape Horn, by Dr. James Eights, of Albany. It certainly appears to be of the same genus and very closely resembling in most specific differences, the fossil specimens from the Mohawk. Dr. E. has, what I believe to be another species of trilobite, which he found at New Zealand. Both of these he will soon publish with figures, when it will be seen, that the longitudinal divisions consists of series of undulations, without grooves, like the species which I have referred to the proposed genus Brongniartia. A. Eaton.

Rensselaer School, March 6, 1832.

7. *Diluvial scratches on Rocks.*

Extract of a letter written by John Ball, Esq., of Lansingburgh, N. Y.

"While on a mountain in Hebron, New Hampshire, I was surprised to find scratches on the rocks, as though made by some heavy body dragged over them. They were uniformly in the same direction, and, judging by the eye, about S. 60° E., N. 60° W. The scratches appeared on all parts of the mountain, and very distinctly when the soil had been lately removed. The mountain is principally gneiss, and the strata inclining a little to the west from a vertical position. I afterwards found that most of the mountain rocks, in that vicinity, show similar scratches. At the time, I was not aware that any thing of the kind had been noticed by others. But on looking into the American Journal of Science, a few days after, I found myself not the first observer of what I deemed a very striking phenomenon."†

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* Καρκῖνος, crab, εἶδος, appearance.

† See Vol. XX, p. 124.

8. *Mineralogy and Geology of Nova Scotia, by C. T. Jackson and F. Alger.* Memoir—from an *unpublished* Vol. of the Trans. of the Am. Acad. Boston; pp. 116 with a map and views.

The original of this excellent memoir, appeared in this Journal in 1828—9. Since that period, the authors have revisited and reexamined the country in question, and by a careful revision, and enlargement of their memoir, giving it a highly improved form, they have made it well worthy of republication, in the Transactions of the American Academy. This memoir may well be proposed, as a model to future explorers of districts yet undescribed, especially on the North American Continent. It is exact and scientific, both in its generalizations and in its details, and it gives due prominence to the very important deposits of useful minerals, with which Nova Scotia and the vicinal parts of New Brunswick abound. Its geological speculations are reasonable and philosophical; the style is perspicuous and correct, and *the getting up* is in every view worthy of the memoir, which might well find a place in the Geological Transactions of London. Nova Scotia is evidently based upon granite, although that rock is almost every where covered by more recent formations, or appears only in loose boulders on the surface.

A transition slate, with marine organic remains, and containing beds of limestone, and very rich beds of iron ore covers the greater portion of the country; the iron ore, an oxide, sometimes a peroxide, is itself often beautifully impressed with organized bodies, and sometimes a shell is half moulded in the slate, and the other half adherent to the iron ore, thus evincing their contemporaneous formation.

The sandstone formation is next in extent after the slate, and it is the most important to the interests of the country. It corresponds, geologically, with the new red sandstone or red marl of England. It contains great beds of gypsum, and it is from this deposit that the gypsum imported into the Atlantic American States is derived; grind stones, which also form an important article of commerce between the two countries, are obtained from the same formation; beds of coal are moreover explored in it, and this valuable mineral is now finding its way into the Eastern States, both from the peninsula of Nova Scotia, and (if we are not misinformed) from the island of cape Breton, which is separated, only by a very narrow strait, from the north eastern main land. As there is no bituminous coal, in any quantity, hitherto discovered in New-England (nor from the geological character of the country, is it probable that there ever will be;) as the

Nova Scotia grind stones, having already a great market, in the Atlantic States, will continue to maintain it on account of their excellence and of their being so easily transported by water, notwithstanding the successful introduction of our fine grained mica slate and arenaceous quartz rock, for the same purpose; and as the gypsum of Nova Scotia can be always brought to the Atlantic ports cheaper than from the interior of New York, and of the Western States; it is therefore probable that these important interests will long contribute to a friendly intercourse between the countries; not to mention that the rich beds of iron ore may hereafter, either in the crude or wrought state, contribute to a similar result.

The trap formation of Nova Scotia is most remarkable. Although no where over three miles in width, and often not over one mile, it stretches one hundred and thirty miles, in continuity, along the south eastern shore of the bay of Fundy; it rises in stupendous precipices, and basaltic columns of three or four hundred feet in elevation, and thus fixes an impassable barrier to the restless tides; those raging waters which, twice in twenty four hours swell to the height of sixty feet, and whether fluent or refluent, rush, with frightful fury, along this rock-bound coast, and into the Bay of Mines, and Chignecto Bay, and their ramifications, undermining and tearing away immense masses of rocks, and piling them in accumulating spoils, along the shores. It is obvious from the fine colored geological map and section, and from the beautiful scenic views, by which our authors have so fully illustrated and adorned their description, that there are few regions in North America, so well worthy of being visited, on account of their wild and picturesque scenery; it is also obvious that no small courage and prudence are requisite in coasting, in boats, along these, otherwise inaccessible cliffs, lest the sweeping deluge which scarcely stops longer than to reverse its course, before it again rushes along with irresistible violence, should engulf the adventurers, or dash them upon the cliffs, which afford scarcely a landing place or a shelter. Our authors themselves, once escaped, with great difficulty, by suddenly clambering vertical cliffs of three hundred feet. The minerals imbedded in the trap, and mixed with its fallen ruins afford a rich treat to the mineralogist, and for beauty, variety and abundance combined, are, we believe, without a parallel in the explored parts of North America. By the liberality of the gentlemen to whom we are indebted for these interesting observations, we have been allowed to receive, and have seen in the hands of others, crystals or masses of quartz, amethyst, chabasie, calcareous spar, analcime, laumonite, mesotype, stilbite, smoky quartz, chalcedony, agate, beryl, specular iron, &c. &c. which both for size and finish, may well be placed among the beauties of our cabinets.

We have not space or time, to give an analysis of this able memoir, and it is rendered unnecessary by the account of the principal facts already given in a preceding volume of this Journal. It is our object in this notice to direct the attention both of scientific and of practical men, not only to the memoir but to the country which it describes. With the increasing facilities of communication, (which however cannot quite conquer time, space and the elements) a voyage from Boston to Nova Scotia may become a favorite and improving excursion, for a few of the weeks of summer.

9. Conchology.—Mr. Lea *on the* Naïades, *in the Transactions of the American Philosophical Society.*—The mollusca of our seaboard have hitherto attracted little attention, except for purposes of food. We never see their dwellings employed as articles of fancy or decoration, with the exception of the common Scallop, whose unpolished exterior must first be concealed by a coating of varnish and a border of gilding, before it is thought fit to enter into the construction of a card-rack. Even the conchologist is forced to summon both his philosophy and patriotism, ere he can admit the pale Purpura, the homely Venus, and the uncolored Pecten to take their respective places in his cabinet by the side of their gaudy congeners from foreign seas. But if our marine shells are limited to a comparatively small number of species, and are, for the greater part, uninteresting in their forms and colors, it is far otherwise with the shelly inhabitants of our inland seas, and fresh water rivers, where the family of the Naïades revel in a profusion and beauty unsurpassed in the known world. So remarkable are these shells for the variety of their tints, and the delicacy of their markings as well as for their dimensions, that they attract the curiosity of the uneducated in the regions where they occur, and may often be found among the ornaments of the rude cabin upon the banks of the Ohio, as well as upon the mantel-pieces of the rich in the larger towns and villages of the west; while, what is more important, they have in numerous instances been the occasion of awakening a taste for conchology, and have become the basis of scientific collections in natural history.

The first persons who occupied themselves with the scientific examination of this family, were Messrs. Barnes and Say; the results of whose labors, especially those of the former, are contained in the pages of this Journal. Mr. Say still continues to devote his attention to the Uniones, as appears from the numbers of the American Conchology, published at New Harmony. Dr. Hildreth, of Marietta, has also contributed his share towards the elucidation of the Naïades. But the papers of Mr. Isaac Lea, in the Transactions of the American Philosophical Society, stand pre-eminent among all the labors of this kind, both for extent and nicety of discrimination. This gentleman has explored, in person, their localities, and has had the good fortune to receive, from time to time, the most abundant supplies of them from his friends, resident at the west; so that his cabinet, as all can testify who have examined it, illustrates the different species in a high degree of completeness,—containing individuals of all ages, and from distant localities, and those which exhibit, also, the various accidents under which they are liable to occur. Nor have his examinations been confined to the mere shells and dead animals: he has preserved the same individuals alive under his eye for months, and the observations he records concerning their habits and anatomy, are extremely interesting and original.

The number of species put forth by Mr. Lea, as new, is so great, as at first to excite the suspicion, that many of them must eventually prove mere varieties of one another, or of older species; but whoever will carefully peruse his memoirs, and much more, examine his cabinet, will be satisfied that the grounds of his distinctions are at least as stable as those of the most distinguished writers upon these, confessedly, most difficult genera in which, says Lamarck, "*les espèces se nuancent et se fondent les unes dans les autres, dans le cours de leurs variations.*"

We shall now glance at the most important contents of Mr. Lea's several papers; commencing with his view of the genus Unio, so far as our own country is concerned. The first column exhibits the nomenclature of the species as proposed by him for general adoption, the second the species described by other writers which are either the same or varieties, and consequently synonyms.

1. U. radiatus, Gmelin.	1. radiata, Lam. 2. virginiana, Lam. 3. radiatus, Barnes.

2. U. complanatus, Soland. MSS.	purpureus, Say. rarisulcata, Lam. coarctata, Lam. purpurascens, Lam. rhombula, Lam. var. *b*. carinifera, Lam. georgina, Lam. sulcidens, Lam. caroliniana, Bosc. fluviatilis, Green.
3. U. ovatus, Say.	ovata, Lam. ovata, Valenciennes.
4. U. cariosus, Say.	luteola, Lam. cariosa, Lam. crassus, (old) Say. carinatus,(rayed) Barnes. ellipticus,(young)Barnes.
5. U. nasutus, Say.	rostrata, Valen.
6. U. cylindricus, Say.	naviformis, Lam. naviformis, Valen.
7. U. subtentus, Say.	
8. U. undulatus, Barnes.	
9. U. plicatus, Le Sueur.	crassidens? Lam. peruvianus, Lam. rariplicata, Lam. crassus, Barnes. undulata, Valen. dombeyana, Valen.
10. U. rectus, Lam.	prælongus, Barnes. nasuta, Lam. purpurata,? Lam. recta, Valen.
11. U. torsus, Rafinesque.	
12. U. mytiloïdes, Rafin.	undatus, Barnes.
13. U. metanever, Rafin.	nodosus, Barnes. rugosus (flat), Barnes.
14. U. scalenius, Rafin.	
15. U. cornutus, Barnes.	
16. U. verrucosus, Barnes.	verrucosa, Valen. tuberculosa, Valen.
17. U. tuberculatus, Barnes.	
18. U. gibbosus, Barnes.	mucronatus, Barnes.
19. U. cuneatus, Barnes.	

20. U. ventricosus, Barnes.
21. U. siliquoïdeus, Barnes. inflatus, Barnes.
22. U. triangularis, Barnes.

The following are the American species added by Mr. Lea: viz. 23. U. parvus, 24. U. æsopus, 25. U. calceolus, 26. U. lanceolatus, 27. U. donaciformis, 28. U. ellipsis, 29. U. irroratus, 30. lacrymosus, 31. U. ater, 32. U. rubiginosus, 33. U. heterodon, 34. U. sulcatus, 35. U. planulatus, 36. U. circulus, 37. U. multiradiatus, 38. U. occidens, 39. U. securis, 40. U. iris, 41. U. zig-zag, 42. U. patulus, 43. U. trapezoïdes, 44. U. multiplicatus, 45. U. asperrimus, 46. U. congaræus, 47. U. oriens, 48. U. brevidens, 49. U. pustulosus, 50. U. stapes, 51. U. pustulatus, 52. U. lens, 53. U. anodontoïdes, 54. U. glans, 55. U. elegans, 56. U. ebenus, 57. U. asper, 58. U. fabalis, 59. U. soleniformis, 60. U. acutissimus, 61. U. varicosus, 62. U. castaneus, 63. U. multistriatus, 64. U. decisus, 65. U. obesus, 66. U. pyramidatus, 67. U. trigonus, 68. U. formosus, 69. U. perplexus, 70. U. angustatus, 71. U. arcæformis, 72. U. subrotundus, 73. U. subovatus, 74. U. pileus.

Mr. Lea's new genus Symphynota, we announced in Vol. XVI, p. 378 of this work: here follows the nomenclature of that genus so far as it is contained in his published papers.

1. S. lævissima.		
2. S. bi-alata,		Local. Canton.
3. S. alata,	Unio alatus, Say and Barnes. —— alata, Lam. and Swainson.	
4. S. complanata,	Alasmodonta complanata, Barnes.	
5. S. compressa.		
6. S. gracilis,	Unio gracilis, Barnes. —— fragilis, Swainson. —— planus, Barnes.	
7. S. tenuissima.		
8. S. ochracea,	Unio ochraceus, Say.	
9. S. cygnea,	Mytilus cygneus, Lin. Anodonta cygnea, Lam.	Local. Europe.
10. S. bi-lineata,		Local. Hindostan.
11. S. inflata.		

Mr. Lea has figured all his species of American Uniones, together with two foreign species of the same genus, (the one from India and the other probably from Africa,) which he proposes as new, under the names of *incurvus* and *olivarius;* also, his six newly described species of Symphynota; and his last memoir contains descriptions and figures of four new species of Melania: viz. *elongata*, *subularis*, *tuberculata* and *acuta;* of one species of Helix, which he calls *Caroliniensis;* of two species of Carocolla: viz. *helicoïdes* and *spinosa*, and of one species of Valvata, named by him, *arenifera*. He proposes also, the *Fusus fluvialis* of Say as a new genus; for the reason that the Canalifera are universally pelagian shells, while this is a fluviatile species, and therefore falls within the Melaniana. He calls it the *Io fusiformis*,—accompanying his description of it with figures.

With respect to Mr. Lea's distribution of the Naïades into the two genera Unio and Symphynota,—the distinctive character for the former being *valves free*, and for the latter, *valves connate*,—it appears to us a real improvement, and one for which he deserves the thanks of all conchologists; since it banishes several genera, and provides in a natural and convenient manner for the disposition of the whole family. Certain it is, that the diagnosis of the old genera Anodonta, Iridina, Alasmodonta, Hyria and Dipsas was too difficult, if not in many instances wholly impracticable. We shall quote Mr. Lea's observations upon the insufficiency of the teeth to furnish among the Naïades the grounds of division into genera.

"The hinges in the species of the different genera glide or shade away so completely into each other, that I have no hesitation in saying it is entirely impossible for any naturalist to mark out a line of unvarying character to most of them."

"If we examine the *Anodonta cygnea*, (Lam.) we find the margin under the beak and ligament to be an uninterrupted line. In the *Iridina nilotica*, (Sowerby) this line is slightly interrupted under the point of the beak. In the *Anodon areolatus*, (Swainson) we have this interruption more distinctly marked, the elevations being larger and more curved, evidently forming an incipient tooth, which approaches very closely to the *Alasmodonta marginata*, (Say,) and forms with it a natural link. The next in the chain appears to be the *Alasmodonta rugosa*, (Barnes,) which has an incipient lateral tooth; and that which follows very closely is the *Unio calceolus*, (Nob.) which has the lateral tooth very slightly more defined than the preceding. In the *Symphynota compressa*, (Nob.) we have the tooth more perfect and extended, forming a moderately well characterized lateral tooth of the genus *Unio*. The well known *Unio pictorum* (Mya pictorum, Lin.) presents us with cardinal and lateral teeth completely formed. In this genus, the *Unio*, we have an infinite variety in the forms of the teeth. In the *Symphynota alata*, (Nob.) the cardinal and lateral teeth are compressed in most specimens; and the next change we find, is in the *Hyria avicularis*, (Lam.) in which the cardinal tooth is somewhat lamellar and forms nearly a line with the lateral tooth. The next 'nuance' is in the *Symphynota lævissima*, (Nob.) which possesses lamelliform cardinal and lateral teeth forming nearly a complete arc. Then follows the *Symphynota bi-alata*, (Nob.) the uninterrupted curved tooth of which is little more than an elevated line under the ligament and beaks. As far as one may be able to judge from a bad description and very bad drawing, the *Dipsas plicatus*, (Leach,) may be with propriety placed at the end of this suite."

Mr. Lea's critical examination of Lamarck's species of the genus Unio constitutes a valuable part of the introduction to his paper, read before the Philosophical Society, March 6th, 1829; and we extract the substance of it for the satisfaction of those persons who may ever have exercised themselves with the determination of Uniones by the aid of Lamarck.

1. U. sinuata, Lam.	Alasmodonta margaritifera. Say. Mya margaritifera. Lin.
2. U. elongata, Lam.	There can scarcely be a doubt but that it is a young shell of No. 1.
3. U. crassidens, Lam.	Consists of the *ponderous* varieties of several species.
4. U. peruviana, Lam.	Embraces the *plicata* of Le Sueur, the *crassus* and *undulatus*, of Barnes, the *rariplicata* and *crassidens* of Lam. and the *undulata* and *dombeyana* of Valenciennes. Le Sueur's name must take the precedence. Its habitat is probably the U. States, and not Peru.
5. U. rariplicata, Lam.	A variety of No. 4.
6. U. purpurata, Lam.	Answering in every respect to the *recta*, but in habitat.
7. U. ligamentina, Lam. 8. U. obliqua, Lam. 9. U. retusa, Lam.	Descriptions too imperfect to admit of their being identified with any of our individuals; although they are all from this country.
10. U. rarisulcata, Lam. 11. U. coarctata, Lam. 12. U. purpurascens, Lam.	Mere varieties of the *complanatus*.

13. U. radiata, Lam.	Lamarck gives the *Mya radiata* of Gmelin and U. *ochraceus* of Say as synonyms to this species. But, these are perfectly distinct. The *radiatus* of Barnes after Lam. is distinct from Say's *ochraceus*, and there is no doubt but that the M. *radiata*, G. differs from both.
14. U. brevialis, Lam.	Resembles the *circulus* of Ohio, but is larger, less round and radiated. It is, no doubt, a distinct species.
15. U. rhombula, Lam. 16. U. carinifera, Lam. 17. U. georgina, Lam.	Varieties of the *complanatus*.
18. U. clava, Lam.	Cannot be identified with any of our shells.
19. U. recta, Lam.	The same as Barnes's *prælongus*. The *recta* being described first, should be retained.
20. U. naviformis, Lam.	U. *cylindricus* of Say, and previously described: the *naviformis*, therefore, cannot stand.
21. U. glabrata, Lam.	A variety of the *cariosus* most probably.
22. U. nasuta, Lam.	Either the *recta* of Lam. or the *gibbosus* of Barnes.
23. U. ovata, Lam.	The *ovatus* of Say.
24. U. rotundata, Lam.	The *circulus* of Lea.
25. U. littoralis, described by Draparnaud, who says it resembles the *margaritifera*, but is much smaller.	
26. U. semirugata, Lam.	Cannot be identified.
27. U. nana, Lam.	Habitat is Franche Comté.
28. U. alata, Lam.	*Alatus* of Say and *Symphynota alata*, of Lea.
29. U. delodonta, Lam.	Description too short.
30. U. sulcidens, Lam.	A variety of *complanatus*.
31. U. rostrata, Lam.	The specimens sent Mr. Lea from Europe, are only varieties of the *pictorum*.
32. U. pictorum, Lam.	Mya pictorum, Lin.
33. U. batava, Lam.	The specimens sent Mr. Lea from Europe, appear to be only varieties of the *pictorum*.

34. U. corrugata, Lam.	Undoubtedly distinct.
35. U. nodulosa, Lam.	Possibly the young *Alasmodonta undulata* of Say.
36. U. varicosa, Lam.	Resembles the *A. undulata*, Say.
37. U. granosa, Lam.	A distinct species.
38. U. depressa, Lam.	" Do.
39. U. virginiana, Lam.	*radiatus* of Barnes.
40. U. luteola, Lam.	A variety of Say's *cariosus.*
41. U. marginalis, Lam.	Distinct.
42. U. angusta, Lam.	A variety of *pictorum.*
43. U. manca, Lam.	It may be a distinct species, but resembles a variety of *pictorum.*
44. U. cariosa, Lam.	The *cariosus* of Say.
45. U. spuria, Lam.	Cannot be identified with any of ours.
46. U. australis, Lam.	Cannot be identified with any American shell.
47. U. anodontina, Lam.	Probably the *Anodonta undulata* of Say.
48. U. suborbiculata, Lam.	Cannot be identified.

Mr. Lea concludes his review of Lamarck's genus with the following candid remarks respecting the reputation of that conchologist.

"In passing criticisms upon the species of the genus Unio, of this great naturalist, I do not in the least wish to detract from his great and merited fame. My object is expressly to endeavor to facilitate the study of this interesting genus, and to remove as far as I have it in my power, the confusion which has crept into it. My observations, I wish to pass only for what they may prove to be worth."

With respect to Mr. Lea's observations on the structure and habits of the animals which construct these shells, we find his remarks upon the anatomy of the Unio irroratus (Lea,) the most deserving of attention. He has been the first observer of any anatomical difference among the Naïades. The peculiarity relates to the form and position of the oviducts; and is one which is obviously indispensable to suit the construction of the shell. It is an adaptation of the utmost felicity; and would seem to be the result only, of a most intricate geometrical calculation.

In relation to the food of the Naïades he remarks in his last paper as follows:

"I have in vain attempted to satisfy myself as to the nature of their food. Dissatisfied with the results of the observations mentioned in volume third, I procured, among other species, a fine *Unio cariosus*, the valves of which were much more gaping than usual. Selected specimens of various species were placed in a glass vase, in the bottom of which was placed clean white sand, so that their natural beds might be somewhat imitated. In this vessel they assumed their natural position by pushing the sand behind them with the protruded foot, thus forming a pit into which the base of the shell gradually fell, the ligament taking the most elevated situation. In this position, they soon began to travel round the vessel, and this locomotion continued for some days, when it ceased entirely.

"Their extreme timidity or apprehension on the approach of danger was very evident. At first, the slightest agitation, or movement of the vessel caused them to close their valves instantly. Being almost daily disturbed, this alarm after a time ceased, particularly with my fine *cariosus*, which now suffered even the agitation of the water without closing the valves, stretching out its fine dark and beautiful tentacula from the borders of its mantle, and forming by the contact of its edges, two openings, one below the other.

"From the superior of these openings, the constant stream ejected could be plainly perceived for two inches, elevating the water at its surface. Being very anxious to ascertain through what part the water necessary to supply this stream was carried into the shell, I discovered it, after many experiments, to pass in by the inferior opening; that it passed out by the superior one had always been evident. This operation was unremitted while the water was fresh; when left unchanged for some days, this current invariably ceased. Doubting the correctness of my former idea, as to the probability of their feeding on animalcula, from the circumstance of finding the passage of the water to exist only while fresh, and never when animalcula were visible even with a microscope of great power, I instituted some experiments by passing pieces of bread, very small pieces of worms, &c. between the tentacula. Several of them would sometimes remain for some minutes within the mantle, and so far within as to be invisible, but they were in every case in a very short time thrown out with a rapid and sudden jet of water to the opposite side of the vessel.

"These experiments were frequently repeated during the course of a year upon the same specimen, and the result was uniformly the same. No food introduced into the shell could be ascertained to have remained; it may therefore be pretty safely concluded, that neither animalcula, nor food in a more solid state are necessary to the nourishment of the *Naïades*. What then are we to conclude it to be? would the decomposition of water serve the purpose of nourishment as well as breathing? Certain it is, that during the many years I have been in the habit of almost constantly having them alive for examination, dissection, &c. I have never in any instance given them food, unless it was conveyed invisibly to them in the pure water with which our city is supplied, through our works from the river, and which was given them every few days."—Vol. IV, p. 75.

We have not yet remarked upon the descriptions of the species, and the manner in which they are figured. Here, if we are not much deceived, Mr. Lea will be acknowledged to have succeeded in the happiest manner. His language enables the conchologist to form a definite idea of what he would include within his species; and the remarks which are appended to the general descriptions are well adapted to enlighten the student in the determination of difficult individuals; while his figures may be said to be executed *à merveilles*. They certainly surpass every thing of the kind yet done in the United States, and fairly rival similar works of foreign production. And we have only to say in conclusion, we know not which, the society whose transactions they adorn, have most reason to congratulate themselves upon,—the science, or the taste of Mr. Lea's contributions.

10. *A Manual of the Ornithology of the United States and Canada. By Thomas Nuttall, A. M. F. L. S. Cambridge. Hilliard & Brown. pp.* 682.—" After so many excellent works have appeared," says the author, " on the birds of the United States, it may almost appear presumptuous, at present, to attempt any addition to the list. A compendious and scientific treatise on the subject, at a price so reasonable as to permit it to find a place in the hands of general readers, seemed, however, still a desideratum; and to supply this defect, has been a principal object with the author of the present publication."

We rejoice once more to hear from the accomplished naturalist whose name appears in connexion with the above mentioned work. Mr. Nuttall is well known to have been an ardent admirer of the feathered tribes for these twenty years; the greater part of which period he may be said, literally, to have passed in their society. His habits of observation, as well as powers of description, were well suited to the task he has performed, as all will readily acknowledge who peruse the work. And appearing as it has, before the arrival of our native birds from their winter retreats, we venture to predict for them a heartier welcome the present season than they have ever experienced before among the hills and vales of New England.

His introductory chapter, which consists of thirty closely printed pages, describes the anatomy of birds—their food, and the modes of obtaining it—their senses and instincts—vocal powers, and skill in imitating sounds—their conjugal affection—nidification and geographical limits; and is rich with instruction and interest to the general reader. We cannot refrain from quoting the opening remarks of this essay.

"Of all the classes of animals by which we are surrounded in the ample field of nature, there are none more remarkable in their appearance and habits than the feathered inhabitants of the air. They play around us like fairy spirits, elude approach in an element which defies our pursuit, soar out of sight in the yielding sky, journey over our heads in marshalled ranks, dart like meteors in the sunshine of summer, or seeking the solitary recesses of the forest and the waters, they glide before us like beings of fancy. They diversify the still landscape with the most lively motion and beautiful association; they come and go with the change of the season, and as their actions are directed by an uncontrollable instinct of provident nature, they may be considered as concomitant with the beauty of the surrounding scene. With what grateful sensations do we involuntarily hail the arrival of these faithful messengers of spring and summer, after the lapse of the dreary winter, which compelled them to forsake us for more favored climes. Their songs now heard from the leafy groves and shadowy forests, inspire delight, or recollections of the pleasing past, in every breast. How volatile, how playfully capricious, how musical and happy, are these roving sylphs of nature, to whom the air, the earth, and the waters, are almost alike habitable. Their lives are spent in boundless action; and nature, with an omniscient benevolence, has assisted and formed them for this wonderful display of perpetual life and vigor, in an element almost their own."

The descriptions of the birds are replete with interesting information, conveyed in the most animating and naïve manner; and the work is illustrated by a large number of very beautiful wood cuts. We think that it will prove to be a favorite treatise, since we are satisfied that it possesses strong claims to public approbation.

11. *Statistics of Iron in the United States.*—The author of the article Iron in the Encyclopædia Americana, desires to correct his statement therein made, respecting the annual produce of bar iron

in this country. At the time the estimate was made, now above a year ago, he found it impossible to obtain any information worthy of confidence relating to the subject, out of the Iron districts of New England and New York; accordingly, he was left to bare conjecture concerning those parts of the United States which recent investigation shows to be by far the most productive in this article of any portion of the country. The following statements are derived from the Report on the product and manufacture of Iron and Steel, made at the direction of the General Convention of the Friends of Domestic Industry, assembled at New York, Oct. 26, 1831;—B. B. Howell, *secretary*. Of which report it is not too much to say, that it bears the marks of an indefatigable and honest examination of the whole subject. Nor can there be a doubt, that the annual produce is yet to be increased by returns from remote sections of the country, which have not hitherto reached the committee.

The number of furnaces in operation during the year 1830, was 239, and the quantity of iron yielded by them, was 191,536 tons; of which 112,866 tons were converted into bar iron. The value of all which, according to the mode of estimation adopted by the committee and explained in their report, was $13,329,760.

12. *Cabinet of Minerals, &c.*—Dr. Lewis Feuchtwanger, No. 377, Broadway New York, as we are informed, offers his cabinet of minerals and other object in Natural History for sale, either entire, or in single specimens. We understand that they have been collected with much labor and expense, and that many of the specimens both rare and beautiful, have been exhibited in some of the public establishments in that city. Among them are, a large wax yellow Amber, of nearly 2lbs. weight, and 60 cubic inches magnitude, from the Baltic.

An American Beryl, of 70 lbs. weight, and 620 cubic inches.

A full six sided Prism, of 27 circumference.

Three collections of precious stones, containing all possible varieties, from the diamond to the flint.

Three small private collections of 160, 350, and 940 specimens, besides several other natural curiosities, such as the teeth of the mammoth, preserved reptiles, and fish impressions, &c.

The auro-plumbiferous Tellurium, the graphic Tellurium, Bournonite, Mellite, Silver, Strontian from Sicily, Idocrase, Zeolite family, Opal family, Humboldite, Vivianite, Hydrophane, Hypersthene, Allophane, splendid Apatite in crystals, &c. &c. &c.

13. *Historical and Philosophical Society of Ohio.*—A society with the above designation, has been chartered in Ohio, by its Legislature. The names of its founders give good promise that it will not slumber, like too many of the societies in the older states; and as the character of the West is eminently, *to be up and doing*, we look for fair fruits of knowledge and of positive utility from this new and hopeful institution.

14. *Corrections in Hassler's Logarithmic Tables.**

Newport, February 17, 1832.

To Professor Silliman.—*Dear Sir*—I take the liberty of presenting to your notice a few errors discovered in Hassler's logarithmic tables, as follows:

In the tables of Numbers.

The natural	number	2940	is	misprinted	3140
"	"	" 3010	"	"	3910
"	"	" 3960	"	"	5960
"	"	" 8640	"	"	7640

In the table of Natural Sines.

Sine of 16° 42′ 30″, for 002874998, read 0,2874998. Cosine of 9° 30′ 00″, and throughout the whole column to 9° 60′; for 0,936, &c.; 0,935, &c.; 0,934, &c.—read 0,986, &c.; 0,985, &c.; 0,984, &c.

These errors are all evident on a slight examination of the tables, and are therefore easily detected, but they serve to awaken a distrust of the accuracy of other parts of the work, in which errors would be less apparent and therefore more mischievous.

These tables of Mr. Hassler are so admirable for their general form and arrangement, for their small volume, and their exceeding usefulness even for the higher computations of mathematics, that the publication of them in our country may be considered as no small subject of gratification to our national pride.

Mr. Hassler professes, in the title page, to have presented to the world a set of logarithmic tables, "in which the errors of former tables are corrected." But his reader of proofs has obviously left many of his own, to be corrected, it is earnestly hoped, in some future edition.—J. R. V.

* From Mr. Hassler's known candor, we doubt not he will be obliged by any communication tending to render his valuable tables more free from typographical errors.—Ed.

15. *Notice of the tropical plant Guaco.*

Guaco, Huaco,—Mikania Guaco, *Humb. & Bonpl.*

The stem and all other characters of this plant correspond very much with the those of the whole genus Mikania; this species has a strong odor, and grows on the borders of rivers and streams in warm and humid places of the northern coast of Colombia, in Mexico, Yucatan, and also in some islands of the West Indies.

This plant, from the great and unrivalled medicinal qualities which are attributed to it by the natives of those climates where it is found, being used by them as an infallible antidote for the bite of venomous reptiles, and as a remedy in many other diseases, and from the close affinity which it bears to our boneset, (Eupatorium perfoliatum,) one of our most valuable medicinal plants, assuredly merits a thorough examination; a knowledge of its properties might lead to important consequences, at least it would enable us to determine, how far it differs from boneset, and with what safety or advantage it might be employed as a substitute.

The guaco is used as a medicine both internally and externally; internally by taking a juice extracted from its leaves, externally by inserting the leaves themselves, in punctures made in the flesh of the patient; it is not only valuable as a preservative against the bite of snakes, but is also found to be effectual in preventing all dangerous consequences in case a wound should be received, and the external application or inoculation is therefore repeated semi-annually by the Indians and other inhabitants.

I am of opinion, that this valuable plant might be introduced with advantage into this climate, where it would be as likely to flourish as many others which are common with us and appear to bear to it a close affinity.

I have now in my possession a supply of a concentrated tincture of the Guaco and its seeds.

Dr. Lewis Feuchtwanger.

New York, March 6, 1832.

16. *Magnetism.*—The researches of Mr. Hansteen of Christianna, on the northern magnetic poles, and the discovery of the great increase of power by the application of galvanism to the magnet, afford a hope, that ere long some further light will be thrown on this mysterious agent of nature.

The connexion between heat and cold, and the magnetic phenomena, is shown by numerous facts, and could any plausible solution be offered for the phenomena of magnetism by the different states of temperature of the earth, and of the probable composition of terrestrial bodies, it would be more accordant with what we observe in nature, than in supposing four revolving magnets in the interior of the earth.

There are facts which seem to favor the. following positions.

1. *That the coldest points in the northern hemisphere are the magnetic poles, and that these in all probability lie under the arctic circles.*

2. *That the poles of the magnet in passing from the northern to the southern or from the southern to the northern hemisphere are reversed, by the magnetism of one end of the needle passing to the other.*

I would be glad to learn how far you think these suppositions probable, or whether their fallacy can be shown from any thing yet known.

Very respectfully your obedient servant,

J. Hamilton.

To Prof. Silliman.

Carlisle, Penn. February 27th, 1832.

It is not in our power to add any thing precise in answer to the inquiries of Mr. Hamilton, and we therefore invite the observations of others.—*Ed.*

17. "*List of officers of the Academy of Natural Sciences of Philadelphia for the year* 1832."—*President*, William Maclure. *Vice Presidents*, George Ord, William Hembel. *Corresponding Secretary*, Samuel George Morton, M. D. *Recording Secretary*, Thomas M'Euen, M. D. *Librarian*, Charles Pickering, M. D. *Treasurer*, George W. Carpenter. *Curators*, J. P. Wetherill, S. G. Morton, M. D., Thos. M'Euen, M. D., and Charles A. Poulson.

Philadelphia, Feb. 16, 1832.

18. Amos Doolittle *the earliest American Engraver.*—Between the present and the preceding No. of this Journal our venerable old engraver, Mr. Doolittle, has descended to the tomb, nor are we willing that his name should float away on the tide of time, without a passing notice. He has often assured me that he was the first person who engraved on copper in this country and this assurance he repeated a short time before his death.

He was born at Cheshire, near New-Haven, and died of the prevailing epidemic Jan. 31st, 1832, at the age of 78, with his faculties and even his eye-sight unimpaired. With only one serviceable eye, he engraved the finest lines without glasses.

Self-taught, he at the age of 21, first commenced the business of an engraver, having previously served a regular apprenticeship with a silver-smith. For more than half a century, he industriously applied himself to this art, and it is believed that he accomplished more personal labor in it than any other individual living. When the news of the Battle of Lexington arrived in New-Haven, Mr. Doolittle, with forty other members of the Governor's Guard, immediately went on to Cambridge as volunteers under Captain Benedict Arnold, (afterwards General Arnold,*) who then commanded the company. While they were at Cambridge, Mr. D. visited the battle ground at Lexington, and upon his return to New-Haven, he made an engraving † of the action, which was his first attempt in this art. In this print, the British troops under Maj. Pitcairn are represented as firing on the Americans, a number of whom have fallen, with the blood streaming from their wounds. The representation though somewhat rude, had at that time a great effect in exciting and sustaining the patriotism of the country. This print is believed to be the first regular Historical Engraving ever executed in America, and it is somewhat remarkable, that about three weeks previous to Mr. D's death, the last day on which he was able to perform any engraving, he was engaged on a copy of this print, which after a lapse of fifty-seven years is republished in Mr. Barber's useful little work, the History and Antiquities of New-Haven.

There were three other historical prints executed by Mr. Doolittle in relation to the expedition to Lexington and Concord, and it is not uninteresting to trace in this country, the progress of the fine arts of painting and engraving during half a century, from this humble beginning, to the historical pictures of Col. Trumbull, four of which adorn the Capitol at Washington; the eight originals will soon be deposited in his native State. The art of engraving remained in a humble state in this country many years after Mr. Doolittle's youthful essays, and he was becoming an old man at the

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* General Arnold was then a citizen of New-Haven and a large house which he erected there, is still in perfect order.

† The drawing was by Earl.

time when the art began to attain high excellence among us. Still his work was very respectable, considering the circumstances of his self managed training; and his maps and machinery, particularly, have done him credit. But it is superfluous to comment upon what may be seen in every volume of this Journal; a work which was not sufficiently patronized to afford, in every instance, the luxury of the most finished engraving; Mr. Doolittle was the American patriarch of the art; an amiable and worthy man and a neighbor of the editor, who felt some satisfaction in cheering his old age, by even so small a mark of confidence, respect and kindness: for, the way of the world, too often, is, to desert an old and faithful servant, in the day when he most needs and merits protection. It is worthy of remark, that Mr. Doolittle's last work for this Journal (as if it were ominous) was *the tomb of Whitney*, which he had not quite finished when he was called to lay down his graver.* The rotascope of Prof. Johnson was executed a few weeks before, and the map of Orange Co. was finished after he was arrested by the influenza which terminated his life. Mr. Doolittle was cheerful in his temper, and assured me, on his death bed, that he had long ago made up his views on the great subjects of a future world and felt his mind in peace in the prospect of death.

19. *Injury sustained by* Dr. Hare *from an accidental explosion of fulminating silver; with remarks on the dangers attending the use of that substance.*—Many persons have sustained injuries, more or less severe, from fulminating silver, and much anxiety was felt for the safety of Dr. Hare, who met with a dangerous accident, of this kind, early in February.

We learn from him that the quantity which exploded was such, as in its light feathery state, nearly filled an ounce bottle. It had been dried on a filter but, in three trials, failed to explode by percussion. By a subsequent exposure in the evaporating oven, it was rendered unusually explosive. Hence as Dr. Hare was in the act of pouring out a small portion, upon the face of a hammer, the whole exploded, without any obvious cause, unless as he suggests, it was a slight pressure, which might possibly have been created upon a particle of the powder, between the neck of the bottle and the hammer. By the explosion, the bones of all the fingers of the right hand, except the little finger, were more or less broken; part of the

* The last hand was put to Whitney's tomb by Mr. J. W. Barber.

flesh of the terminating joint of the thumb was torn off together with the nail, and the latter was found upon the laboratory floor; the corresponding finger was much injured, and the palm bruised and lacerated.

His faithful and experienced assistant, George Workman, was holding the hammer at the moment of the explosion, and was consequently wounded in the face and eyes; into one of the latter, a spicula of glass was driven, which was not removed without skillful surgical aid; he recovered however, in a fortnight. A pupil was wounded slightly in the face, and Dr. Hare himself had a small fragment of glass removed from one of his eyes. Among his late and present colleagues, are some of the most skillful of surgeons, who, with his pupils, were immediately present to afford every necessary aid. It appears, that he had been accustomed, for six years, to pour from the same vial, such portions of fulminating silver as he needed for his experiments, and had never met with any accident. He had, in the present instance, prepared an unusual quantity with reference to some analytical experiments which he had proposed to perform by igniting the powder in a receiver of known capacity, by means of a wire galvanized in vácuo; the quantity of gaseous matter was to be ascertained by a gage, and the kinds by accurate eudiometrical analysis.

Happily, no tetanic symptoms followed, and although the patient suffered intensely, he has been mercifully spared to his family and friends and the world. Excepting some rigidity and tenderness in the renovated muscles, he is now recovered.

* * * * * * *

I cannot dismiss this subject without suggesting some cautions to young experimenters: the most memorable part of my own experience was purchased in July, 1811, at the price of much suffering, and imminent danger of the loss of both eyes. The particulars of the accident were detailed at the request of Prof. Griscom, and published by Dr. Bruce in his Mineralogical Journal: I have also mentioned them more briefly in a note to my Elements of Chemistry, Vol. II. p. 348. It may there be observed, that the fulminating silver, in the act of forming, exploded by a slight pressure, *while still beneath the acid and alcohol*, and therefore wet, and less liable to explode, as one would suppose, than in Dr. Hare's case. I will on this occasion, cite some remarks from the work named above.

"M. Descotils, the discoverer of this variety of fulminating silver, says (Ann. de Chim. Vol. LXII, p. 198, and Nicholson's Journal, Vol. XVIII, p. 141,) that '*a blow or long continued friction causes it to inflame, with a brisk detonation. Pressure alone, if it be not very powerful, has no effect upon it.*' I can account for this erroneous statement, *so dangerous to young operators*, and which has been ever since copied into some of the most respectable treatises, only by supposing that the powder might have contained a mixture of the nitrate, precipitated by the alcohol in consequence of its seizing the water of the solution, (which sometimes happens also in preparing the fulminating mercury,) or that the precipitate was not dry; *it is quite certain, that the fulminating silver, when properly prepared and dry, will bear neither pressure nor friction*, and very little even when wet."

It is well known that careful drying greatly increases the sensibility of the fulminating powders, and their violence when exploded.

My own practice has long been, never to keep either the fulminating mercury or silver in a vial,* whose explosion, especially when held in the hand, must of course occasion injury. It is perfectly safe, to place the powder in small quantities, in little paste board cases covered by a loose card; when moved, they should never be laid in the palm of the hand, but always taken up, by applying the thumb and finger to the edge of the card box; a few grains at a time may then be jarred out, upon a card for use, and in this manner no accident will ever occur. But in pouring from a vial, the mere impetus of falling, may, by the weight alone, cause fulminating silver to explode. I have always found, that when this powder is perfectly dry, it will rarely bear the weight of a common sized hammer, cautiously allowed to press upon it by degrees, and without any blow; and, if sand be previously mixed with the powder, on the anvil, the hammer can scarcely touch the mixture ever so gently, without causing a detonation.

Too much caution cannot be used in the management of fulminating silver, and no considerable quantity of it should be kept on hand, unless in small divided parcels, and in paper boxes as above described.—*Ed.*

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* I was present in Dr. Woodhouse's laboratory in Philadelphia, thirty years ago, when a vial of fulminating mercury exploded, spontaneously, while standing on the table, and from no obvious cause unless it was the jarring, produced by the assembling of the class for the lecture.

20. *Abstract of a Meteorological Journal, kept in the town of New Bedford, for the year* 1831.

Arithmetical Mean of Observations for the several months at the hours stated.										Rain and Snow reduced to water.	Extremes of temp. & Atmospheric pressure				Prevailing winds noted in days.				Atmosphere.			
1831.	Six's self-registering Thermom.					Standard Barometer.					Therm.		Barometer.									
Months.	S. rise	2 clk.	S. set.	10 clk	mean	S. rise.	2 clk.	S. set.	10 clk.	Inches.	max	min.	max.	min.	N. & N. W	W. & S. W.	S. & S. E.	E. & N. E.	Fair.	Cloudy.	Rain.	Snow.
January,	20.5	28.8	25.5	22.4	24.30	29.827	29.797	29.821	29.846	6.64	55	—2	30.37	29.09	18	4	3	6	20	6	1	4
Feb.	21.0	31.0	26.8	23.6	25.60	29.957	29.940	29.977	30.010	3.14	48	8	30.68	28.96	18	5	3	2	22	3	3	0
March,	34.8	46.2	40.9	37.5	39.85	29.955	29.916	29.922	29.949	4.66	60	23½	30.36	29.19	8	13	7	3	16	7	6	2
April,	41.4	53.3	48.0	44.7	46.85	29.874	29.861	29.872	26.884	6.56	61½	31	30.27	29.21	4	11	7	8	14	6	8	2
May,	51.6	66.3	58.4	55.1	57.85	29.939	29.919	29.938	29.962	3.96	86	38	39.43	29.21	5	15	7	4	19	5	7	0
June,	64.2	77.3	69.7	66.3	69.38	30.104	30.095	30.094	30.101	3.13	92	54	30.41	29 85	3	16	6	5	18	6	6	0
July,	65.5	78.9	71.3	68.1	70.95	30.069	30 054	30.049	30.059	6.45	85	52	30.46	29.69	7	21	1	2	19	5	7	0
August,	67.1	79.8	72.2	69.5	72.15	30.150	30.135	30.149	30.151	2.95	90	61	30.37	29.89	5	16	4	6	20	6	5	0
Sept.	58.7	70.5	64.5	61.3	63.75	30.055	30.048	30.055	30.063	5.21	82	43	30.28	29.56	4	15	6	5	18	6	6	0
October,	50.2	61.1	55.6	52.8	54.92	30.074	30.049	30.060	30.063	5.37	74	37	30.48	29.62	9	11	5	6	17	9	5	0
Nov.	36.9	56.4	42.1	38.5	40.97	29.826	29.798	29.825	29.845	3.27	60	22	30.36	28,86	18	7	4	1	21	5	4	0
Dec.	17.4	25.6	21.9	19.2	21.02	29.929	29.895	29.921	29.940	3.05	42	—1	30.46	29.26	21	5	3	2	14	9	1	7
The year,	44 11	55.43	49.74	46.59	48.97	29.980	29.959	29.974	29.989	54.39	92	—2	30.68	28.86	120	139	56	50	218	73	59	15

21. *Dr. Hare's new process for obtaining silicon and boron.*—A new and highly eligible process, for the evolution of silicon, was employed by Dr. Hare and exhibited to his class last winter. Potassium was included in a bell glass filled with fluosilicic acid gas. The potassium was then ignited by galvanism, and an active combustion ensued. This was rendered peculiar by a deep red light, and copious brown fumes which were condensed or aggregated into chocolate colored flocks resembling snow in consistency, and which fell in like manner and coated the interior surface of the bell.

Dr. Hare intended to subject fluoboric acid gas to the same ordeal, but was soon after disabled, for a time, by an injury affecting his right hand; see p. 185 of this No.

Dr. Hare also succeeded in decomposing boracic acid by a new method of heating it with potassium. In our next number we hope to give an engraving of Dr. Hare's apparatus with an explanation, and a detail of his experiments.

22. *Greenstone Dyke.*—Dr. A. Clapp, of New Albany, Indiana, while travelling last spring, discovered, in the town of Montgomery, in Vermont, a greenstone trap dyke of three feet in width, rising through talcose slate. It was in the falls of a stream called South Brook, where it descends from the hills.

23. Vol. IX of the ENCYCLOPÆDIA AMERICANA.—This volume contains in natural history and physics, the articles Ornithology, Organic Remains, Optics, Nitrogen, Oxygen and Geology of North America, all of which appear to correspond, in the faithful manner in which they are prepared, with the related subjects in former volumes.

24. *Whirlwind storms.*—Capt. James Riley, a veteran navigator, well known by his travels in Africa, has addressed an interesting letter to Mr. William C. Redfield, of New York, dated on the Atlantic, March, 1832; in which he fully confirms, from his own experience, the view presented by Mr. Redfield of the nature of violent wind storms. (See Vol. XX, p. 17 of this Journal.) Capt. Riley deduces from his experience certain important rules for the management of ships during those violent gales. See New York Journal of Commerce for March 31, 1832.

25. *A report of observations on the Solar Eclipse of Feb.* 12, 1831.—A report on this subject by Messrs. A. D. Bache, Jos. Rob-

erts, Jr. and Isaiah Lukens will appear in Vol. IV of the Philosophical Transactions of Philadelphia. The report will contain

1. Observations made by Jos. Roberts, Jr. at the Friends' observatory in Philadelphia.
2. " " Sears C. Walker, at a place 1433 feet west of the above named observatory.
3. " " John Gummere, Burlington, N. J.
4. " " Prof. Renwick, Columbia College, N. York.
5. " " Robert Treat Paine, Cape Malabar light house, Lat. 41° 32′ 58.3″ N., Long. 70° 01′ 20″ W.
6. " " F. R. Hassler, city of Washington.
7. " " Prof. R. M. Patterson, Univ. Virginia.
8. Meteorological observations by Prof. A. D. Bache, Univ. Penn.

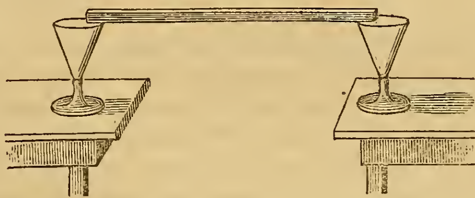
We forbear to quote, from a report which is as yet unpublished.

26. *Chloro-chromic acid.*—Dr. Torrey has repeatedly prepared this compound, called by Dumas, *per-chloride of chromium.* Dr. Thomson in his original memoir on chromium, states that the acid will not inflame phosphorus, while Dumas asserts the contrary. In Dr. Torrey's experiments explosion generally followed the contact of the two substances. This information being communicated to Dr. Thomson, it induced him to repeat his experiments with this energetic compound. It appears (see his New System, Vol. I, p. 339,) that the phosphorus is not affected when it is made *perfectly dry*, and that it may even be fused under the liquid acid in this state. Mr. George Chilton and his son, assisted by Dr. Ellet of New York, as well as Dr. Torrey, have verified all Dr. Thomson's assertions. The best way which they found of getting perfectly dry phosphorus, was to shave off the outside of a stick, so as to remove the whole of the white crust which usually forms on this substance in water. The *salt* employed in making the acid should be *fused* so as to render it perfectly anhydrous.

27. *Effect of Elasticity.*—Having had occasion to illustrate, by the annexed figure, an old but very curious experiment, I have thought it might not be uninteresting to such of the younger readers of this Journal, as have not been made acquainted with it, and I have therefore inserted the following notice.

Place a wine glass upon the edge of a table and another wine glass upon the edge of another table, at the distance of three or four feet;

a pine stick, of one half or three fourths of an inch square, being then laid across the two glasses, so that its two ends may rest upon the two contiguous edges of the glasses, thus;



strike the stick at right angles, in the middle, with a heavy cane and it will break in two, without breaking the glasses. The two pieces of the broken stick fly up to the ceiling, while the glasses remain, not only uninjured, but are not even moved from their places. I have often, successfully, repeated this curious experiment; when, however, the glasses are thin and the stick is too strong, they will break, and they will break in any event, if the stick does not; for it is obvious that their safety depends upon their being strong enough to resist the first impulse of the blow, and that the pressure upon them is relieved, the moment the stick begins to yield in the middle, and that it is entirely removed, when it breaks and the ends fly upwards.

FOREIGN.

28. *East Indian Ferns.*—Descriptions and figures of a select number of new or imperfectly known East Indian ferns, compiled chiefly from the collections of the honorable the East India Company, made by Dr. Wallich in various parts of the Company's possessions, and by Dr. Wight in the peninsula of India, (with the assistance of the MSS. of these botanists;) by William Jackson Hooker, LL. D. F. R. A. & L. S., and Regius Professor of Botany in the University of Glasgow, and R. K. Greville, LL. D., F. R. & A. S. E., & F. L. S. Only a limited number of copies will be published. It will be in two large folio volumes, each containing one hundred colored plates, with dissections, and Latin descriptions, and remarks in English.

To appear in eight parts,—price two guineas for each part, containing twenty five plates with the appropriate letter press.

John Hunneman, Esq., No. 9 Queen street, London, receives the names of foreign subscribers.

Notices Translated and Extracted by Prof. Griscom.

CHEMICAL PHILOSOPHY.

1. *On the grease of Wines.*—White wine is subject to an alteration which is designated in Switzerland and other countries, by the terms *greasy*, and *ropy*, (*tourner au gras*, *graisser*, filer,) a change which takes place after the vinous fermentation has apparently ceased, and the wine has been bottled or closely confined in casks. The wines of Champagne, of Switzerland, and most thin and light wines are very subject to it, especially when the vintage has been wet. The cause of this malady resides in a mucilaginous principle which is developed in light wines; it pervades the whole mass, and puts on a reticulated appearance; a similar change is observable in beer, and in syrups made of sugar of an inferior quality.

Various methods have been pursued for remedying this defect. Common salt is added to the wine, a practice which was adopted, it is said, by the Romans, in consequence of an accidental discovery of an amateur in wines. Having opened an amphora of wine, and being struck with its excellence, he demanded of his slave what he had put into it. The latter, mistaking his master's meaning, fell on his knees, and confessed that he had drank a little of the wine, and had filled up the vessel with sea water.

After two or three months, it is impossible for the most delicate palate to distinguish the taste of salt, and it is admitted that such an addition improves the taste of the wine; but that it prevents the *grease*, is a point much more doubtful.

Another remedy is the addition of Brandy or Alcohol. But the most efficacious means of all is a frequent racking off, or decantation. Wine must never be allowed to *whiten*, that is, to admit the rising of a milky substance which destroys its transparency. When this disease has been contracted, it may often be removed by clarification with fish glue, but this remedy has two inconveniences,—it does not always succeed, and when it does it diminishes the strength of the wine. This deterioration arises, either from the glue, or perhaps from the disease itself, which has occasioned the operation.

Another method of clarifying wines and removing the grease, consists in filtering them through shavings of hazel. For small quantities this method is very good.

When the sale of wine is not pressing, and care is taken to keep the vases which contain them full, and they are allowed to undergo a slow and insensible fermentation and are exposed to the change of temperature which the season brings round, this disease spontaneously disappears. It is rare that greased wines thus treated, are not cured in passing through the cold of one winter.

The attention of chemists has been much engaged with the nature of this quality in wine. M. François, of Chalons sur Marne ascribes it to a substance which is found also in the gluten of wheat flour, and which M. Taddei an Italian chemist, discovered and named *Gliadine.* It is the portion which is soluble in alcohol,—the insoluble portion he called *Zimome.* If an alcoholic solution of *gliadine* be added to clear wine, it becomes milky and assumes, according to M. François, the aspect of greased wine. Berzelius, however, does not believe in the Gliadine of Taddei. He considers it to be *gelatine* and the zimome to be *albumen,* both of which have been long known to exist in gluten. The same chemist has proved that vegetable and animal gelatine are identical in the properties of uniting with tannin and forming an insoluble precipitate. However this may be, Mr. F. has been induced to regard tannin as a remedy for the grease of wine.

He accordingly makes an observation which seems to have escaped all those who had previously examined the subject, that red wines are never subject to the grease. Now the difference between red and white wines is that the red always ferments in presence of the husk and seeds of the grape, substances which contain tannin in abundance, while white wine remains in contact with the husk but a very short time.

It is also a fact that light wines made of grapes deprived of their seeds are more subject to this disease than others. Hence it is probable that the presence of tannin may by precipitating the gelatine, prevent the phenomena of the grease.

The following are M. François's directions. By adding tannin to wine a month or six weeks prior to bottling, it may be preserved from the grease; and this substance being one of those which exists in wine, it may be added without fear, for it communicates no unnatural odor or taste. Twenty grains of tannin to a bottle of wine, or three and a half ounces to a hundred bottles previously well decanted from all sediment, is the proper dose, although in frequent cases this dose must be repeated. If any sediment remain in the wine, a much larger dose of tannin becomes necessary.

Mr. F. affirms that this malady in wine, when once destroyed, never returns.

As the tannin of chemists is an expensive article, obtained from the gall nut by sulphuric acid, or by potash, it is probable that a substitute may be found, in some of the astringent barks or even in the seeds of the grape.

2. *Obesity.*—The celebrated *fat liver pies* of Strasburgh, are made of the livers of geese fattened with great attention. The animal is shut up in a cage, but little larger than its body, and is taken out but twice a day, and then to be fed with about a quart of crude peas. They are introduced with a finger into the pharynx of the animal, which is thus made to swallow this enormous quantity of nourishment, and is then immediately shut up in its cage.

The immediate result of this kind of life is a remarkable obesity, and an enormous developement of the liver, which without any notable change of structure acquired a triple or quadruple enlargement of volume.

Bibulous paper brought into close contact with this fat liver immediately absorbs an oily matter much like melted fat. These livers sometimes weigh eight or ten ounces, and sell from three to five francs. The fattening of geese in this manner is a good speculation, for every part of the animal possesses an intrinsic value;—the fat on many occasions is a substitute for butter, and the flesh is served at table, and although somewhat tough is not the less nutritious; the feathers are much sought after, the quills serve for writing, and even the excrements sell at a high price, as one of the richest of manures.

3. *Premiums for chemical and medical discoveries.*—The French Academy of Sciences on the 13th of June last, decided that the medical and surgical prizes founded by M. de Montyon, should, for the present term, be thus distributed; six thousand francs to M. Courtois for the discovery of iodine; four thousand francs to M. Coindet, for having applied this substance to the cure of goitre and indicated its use in scrofula; six thousand francs to M. Lugol for having demonstrated the proper methods to be pursued in the employment of it, and for having obtained the most happy results; two thousand francs

to M. Sertürner for having ascertained the alkaline nature of morphine, and thus opened the way to important medical discoveries.—*Annales de Chim. Aout*, 1831.

4. *Process for hastening acetic fermentation and for preparing on a large scale, and in an economical manner, strong vinegar in forty eight hours, by M. Dingler.*

The method recommended by this author consists

1. In providing suitable rooms or buildings which can be easily kept at the requisite temperature by stoves, hot air flues or other modes of heating, and by which, during the process of rectification they should be maintained at the temperature of about 100° F. Two or more thermometers should be suspended in the room by which the heat can be regulated.

2. In placing in each of these rooms a convenient number of casks, containing about one hundred and thirty gallons each. These casks must stand erect on blocks of wood which will raise them from one and a half to two feet from the floor. The casks may be constructed with open tops, but a cover must be made of inch plank which will fit accurately into the top and rest upon a hoop or ledge nailed on the inside for a support. This cover is for the purpose of preventing evaporation. A hole of about three eighths of an inch wide must be made in the bung of the cask for the admission of the air which is to oxygenize the materials of the vinegar.

3. In procuring a quantity of wood shavings sufficient to fill the casks when pressed pretty closely together, without being trodden however into a very compact mass. The wood of the red beech is found to furnish shavings of the best quality for this purpose. To prepare the shavings, the wood should be cut into logs two feet in length, split into suitable pieces, and boiled during two hours in water in which it should be allowed to remain twenty four hours. Thus soaked, the wood is, when dry, more easily planed into shavings, which should be about the twentieth of an inch in thickness. If it would be more convenient, the operation of boiling may be performed on the shavings themselves in lieu of the wood.

4. In preparing the liquor, of whatever kind, which is to be converted into vinegar, in the usual manner, for the process of acidification, viz. by mixing it with a proper ferment, if needful, and placing it in a condition favorable to the commencement of the acetic fermentation.

5. In acidifying the shavings, after they are pressed into the casks, by sprinkling upon them, in each cask, about three gallons of good vinegar. At the end of twelve hours, the temperature of the room having been properly kept up, this liquid may be drawn off from the bottom through an opening previously closed by a cork, and again sprinkled upon the shavings. This should be repeated four times in forty eight hours, when the shavings will have absorbed nearly all the vinegar. If this vinegar was not sufficiently strong, a liquid will remain at the bottom which has very little taste, in which case the process should be repeated with fresh vinegar. As the shavings absorb a great deal of vinegar, it is probable that the first operations will not produce a strong acid, but this inconvenience will not long be felt.

The prepared shavings may serve without alteration during three years without being removed from the casks, provided the liquids which are poured upon them are clear and pure; but if they contain foreign matters, which become deposited upon the shavings, the latter must be taken out from time to time, put into a tub with water and well washed by agitation with a broom.

6 and lastly. In hastening the acidification of the fermenting liquid, by pouring it from a watering pot upon the shavings, in quantities of four or five gallons at a time (into each cask) the temperature of the room being upwards of 100° F. and that of the liquid about 75° and thus exposing it over a very extensive surface to the oxygenizing power of the air. As soon as the fluid is sprinkled on the shavings the cover must be carefully replaced. About twelve hours afterward the liquid should be drawn off from the bottom, and again sprinkled over the shavings. At the commencement of the third twelve hours, the shavings may receive a fresh portion of about three quarts of liquid, and then the fluid at the bottom may be again drawn off and sprinkled upon them. This process may be once more repeated at the end of the same time, when being again drawn off, namely, after forty eight hours, it will in general be found to have been converted into good vinegar.

In preparing vinegar from grain, the author recommends the following mode. After the usual vinous fermentation, the greater portion of the clear fluid should be drawn off, and the remainder with the sediment, subjected to distillation. Four or five gallons of the first liquor must be sprinkled on the shavings and then one and a half gallons of the second. The process to be renewed every twelve hours, when in the course of two days the vinegar will be formed, and similar to that from wine.

Clarification.—When vinegar is prepared from alcoholic liquors, it is sufficiently clear to be sent immediately to market, but when liquids are employed that are not free from foreign matters, the vinegar must be clarified.

For this purpose it is put into casks placed on blocks in a cellar, or other suitable part of the premises, which casks must be filled with shavings but without being pressed, and no opening is to be left in the bung. The casks being then filled with the vinegar, it will deposit its impurities on the shavings, and will even by this process acquire strength. When the shavings have become too foul to answer the desired purpose, they must be taken out and washed. The vinegar is also thus deprived of its color. If this is deemed of any consequence, color can easily be communicated by a little burnt sugar or a few myrtle berries.—*Bull. d'encouragement*, *Aout*, 1831.

5. *Nutritious quality of Gelatine.*—In a letter written by M. Roulin, and read to the French Academy on the 11th of July, the following fact is stated; in an excursion made by the Author in 1825, into the forests which clothe the western declivity of Quindiu (Columbia,) the journey which ordinarily occupied but two days, but which was prolonged to fourteen, completely exhausted the provender of the company, and after a fruitless search for some alimentary substance, one of the guides took it into his head to try to eat his sandals which were made of untanned leather, and very soft from the wetness of the woods. He roasted one of them and began to gnaw it. M. Roulin and three persons who accompanied him followed his example. Having each eaten one third of a sole, which cost them not less than two hours mastication, they felt themselves surprisingly restored and resumed their route. They did not however abandon the heart of the palm tree which they had before used, but they found this food recruited their strength far less than a bit of roast leather. They arrived on the fourteenth day, after having eaten five pair of sandals, and a buck skin apron.—*Rev. Ency. Jul.* 1831.

CHEMICAL SCIENCE.

1. *Robiquet on a new metallic Dye.*—(Jour. de Pharm.)—A stuff dyed of a clear bluish grey color was taken to M. Robiquet as able to stand the action of every agent without change of tint, a character which

M. Robiquet ascertained it to deserve. Concluding that it was metallic, it was also concluded that it must be chloride of silver, from its color and characters; on boiling the cloth in ammonia however no silver or chloride of silver was dissolved—the color indeed, became brighter. On incinerating the substance, and digesting the ashes in ammonia, and then in nitric acid, both solvents dissolved silver, the first having taken up muriate of silver, and the latter having dissolved the metal. As if it was not likely that any chloride would be decomposed and brought into the metallic state by incineration, it was supposed that the silver had been applied at first as a nitrate, and then converted into a chloride; the parts which had penetrated deepest having escaped the converting action. Imitations of the dye were therefore made by dipping the cloth first into a solution of nitrate of silver, then drying it, immersing it in a solution of a muriate or chloride of lime and immediately upon withdrawing it, exposing it to light: the color was at once developed, and the success was perfect. By using different strengths of solution of silver, different tints were obtained.

Upon trying the application in a large way, a curious cause of failure occurred. Unless the whole be exposed to the light at once, the color is not uniform; the parts exposed at different times are dissimilar, and hence cloudiness is produced. This may be obviated in some situations, but not in others where space is limited. In printed goods it is supposed that some good application of the idea may be made.—*Jour. of Roy. Inst. No.* 3.

2. *Purple Precipitate of Silver, Gold, &c.*—(Poggendorf's Annals.)—Fischer has shewn that proto-salt of tin yields, with solutions of silver, platina, palladium, and tellurium, precipitates similar to those produced with solution of gold. Frick has shewn that silver precipitate may be prepared of great purity, by using a very pure proto-nitrate of tin, and after adding it to the solution of silver, adding also dilute sulphuric acid. The addition is supposed to prevent the further oxidation of the tin by the free nitric acid, and so also the precipitate. The proto-nitrate of tin is to be prepared by decomposing the proto-muriate by nitrate of lead. In the purple precipitate of silver, the combustion is as strong as in Cassius's purple; the substance is not decomposed either by muriatic acid or ammonia. In preparing the purple precipitate of Cassius, Fischer who first pointed out the superiority of the proto-nitrate of tin in the above experi-

ment to the other salts of that metal, also uses the same solution. It very much surpasses the proto-muriate, and is always successful, whether used in a weak or concentrated state. When proto-nitrate of mercury is poured into a solution of gold, according to Fischer, a blue grey precipitate is obtained quite in analogy with the purple of Cassius. It is composed of deutoxide of mercury and of the sub-oxide of gold, and is not decomposed by muriatic acid; that substance only dissolves a little mercury, and makes the color of the remaining precipitate pass to a clear grey-white.—*Idem.*

3. *On the Manufacture of Sulphuric Ether.*—(C. Wittstock.) The remark of MM. Fourcroy and Vauquelin that the sulphuric acid employed in the fabrication of ether undergoes very little change, led to the conclusion that ether would be formed as long as there was a fresh supply of alcohol to the acid. This supposition was confirmed by the experiments of M. Gay Lussac; and since then, the fabrication of ether has been considerably improved by MM. Boullay, Geiser and others. I have for some time employed the following method; and as I am disposed to consider it more simple and less expensive than any other, a short description of it may perhaps be acceptable to the reader.

A mixture of nine parts of sulphuric acid (sp. gr. 1.84—1.85) and five parts of alcohol (sp. gr. 0.835) are put into a green glass retort of one foot in diameter, with a glass tube inserted at its upper part. This tube is 4 lines in diameter, and bent at a right angle; the shorter arm, which, at its extremity, is only one line in diameter, is plunged one inch deep in the mixture; the longer arm, of about three or four feet of length, with a cock near its further end, leads into a bottle with alcohol. The receiver consists of a refrigerator, viz: a wooden tube, filled with water, by which the distilled ether is kept cool, and two copper vessels, the one within the other, so that there is a distance of about 2 inches between their sides. The neck of the retort leads into the intermediate space between the two copper vessels, which is thus filled with the distilled liquid, and from which the liquid may flow off by any other tube. The apparatus is used in the following manner:—When the mixture is boiling, the cock of the glass tube is opened and the supply thus kept up so that the quantity of liquid in the retort remains always the same; this is continued until eight times the original quantity of alcohol has been used, which will be the case in about 20 hours, if the original mixture consists of 25lbs. of sulphuric acid and 14lbs. of alcohol. The first rectification of ether thus obtained yields about its third of ether of .725 sp. gr. which may of course be considerably increased by repeated rectifications, besides about 20 to 25 per cent of alcohol are regained, which may be subsequently used again, particularly for the supply of alcohol to the mixture. Of 124lbs. of alcohol of 0.835 sp. gr. 22lbs. were regained; the quantity of pure ether of 0.720 sp. gr. at 14°R. amounted to 59lbs., and of sulphuric acid 25lbs. were used. The expenses of fuel, apparatus, attendance, &c. does not raise the price of the ether to more than twice that of its weight of alcohol.—*Idem.*

MECHANICAL PHILOSOPHY.

1. *Remarks on the floating ice met with in remarkably low latitudes in the South Seas;* by Capt. *James Horsburgh*, F. R. S., Hydrographer to the East India Company.—The author remarks that it is rare to meet with floating ice near the Cape of Good Hope and the coast of Africa. The journals of the East India ships make no mention of ice during the last century, although many of these vessels pursue a course which carries them to the Lat. of 40°, 41°, and 42° S.

The author then recites the following instances of the occurrence of southern ice.

1828, April 7. *L'Harmonica*, a French ship, in Lat. 35° 50′ S. Long. 18° 5′ E. of Greenwich, encountered various masses of floating ice, some of which appeared a hundred feet high. The Spanish ship *Constancia*, on the route from Manilla to Cadiz, on the same day, met with several floating islands of ice in Lat. 35° 56′ S., Long. 16° 59′ E. of Greenwich.

1828, April 28. The brig *Eliza*, of Antwerp, in returning from Batavia, in Lat. 35° 31′ S., Long. 18° 17′ E. Saw ice which had the appearance of steeples two hundred and fifty or three hundred feet high, and passed within three fourths of a mile of it. The sea broke with such fury against it, that they would have supposed it lodged against a hidden reef, had not the line proved the absence of soundings.

The East India ship *Farquharson*, April 20, 1829, met with a great mountain of ice in Lat. 39° 13′ S., Long. 48° 40′ E. The dimensions of this floating mass were about two miles in circumference and one hundred and fifty feet above the level of the sea.

Anterior to these instances in 1828 and 1829, it does not appear that ice was ever seen north of 42° or 43° of Lat. in the Southern Ocean. In 1789, the transport ship *Guardian*, was near striking against a mountain of ice in 44° 10′ S. Lon. 44° 35′ E.

In the southern hemisphere, the ice most distant from the pole, has been met with in the month of April. It might then be supposed that in the corresponding month of October, in the northern hemisphere, ice would be found at the greatest distance from the Arctic pole. It appears, however, that it is in the same month of April, or in May that ice is more frequently met with in low latitudes in the northern seas. Several instances of this are mentioned by the author, and the fact appears to be well established.

The existence of a great extent of land near the antarctic circle would seem to be necessary to account for the agglomeration of large masses of southern ice. But as we know of no land in a situation to produce ice, which, by wind and waves setting towards the N. and N. E., could drive masses of ice into the positions in which those of 1828 and 1829 were found, their occurrence must be attributed to some unknown cause, such as an earthquake, or a volcanic eruption the effect of which might be to displace large masses near the southern pole, and thus to produce a phenomenon before unobserved. But even in such a case, the anomaly of its occurence in the month of April, at the same time that the northern ice reaches the lowest latitude, north, would indicate the existence of simultaneous currents, setting from each pole towards the equator, instead of their happening at periods corresponding to the seasons in each hemisphere.—*Bib. Univ. Juin*, 1831.

2. *Red Beets*—(Betterave Champetre,) furnish from a given surface of ground, a greater quantity of nutriment for horses and cattle, than any other kind of forage. Wherever its cultivation is understood, it has the preference over all other roots. It succeeds in almost all soils, is but little affected by the vicissitude of seasons, does not much fear drought; and prepares the ground very well for a succeeding crop.

Throughout Belgium and Germany, the leaves are from time to time stripped off and given to cattle, which eat them with avidity, and easily fatten upon them. Fowls also are fed upon them; they are first hashed up and mixed with bran. Pigs eat them with a good relish. Milch cows when fed upon them, fatten at the expense of their milk. The leaves are equally valuable in the fattening of cattle and of sheep.

Beets should be gathered when the weather is dry, and put away in a dry state, and when prepared for cattle, they must be cut up fine with some suitable instrument, and may be given either alone or mixed with cut straw or hay.

They are equally fit for horses, with the precaution of adding a variety of cut straw and hay well mixed together. This food will preserve them strong and vigorous, as is well ascertained in Germany, where beets are much cultivated for this purpose.

For the fattening of a Bullock forty or fifty lbs. of beets per day, mixed with five or six lbs. of dry fodder will accomplish the object in the space of four months. Care must be taken to give it in three separations, since by feeding often and in small quantities at a time, the same amount of nutriment goes farther.

Finally, by facilitating the means of stable fattening, throughout the year, beets furnish a very important addition to this means of augmenting the mass of valuable manure.

They may serve also, on occasion, for the food of men ;—they are less subject to the vicissitudes of seasons than turnips, and their leaves supply, for several months, an excellent food for cattle. The root may be easily preserved during eight months of the year, they give to milk an excellent taste and quality, cattle eat them with avidity, and are never tired of them. The culture of no forage root can compare with that of the beet in the number of advantages which the industrious cultivator may derive from them. We cannot too strongly recommend the introduction of them into places where they are not already in vogue.—*Idem.*

3. *Feeding of cattle.*—It is stated by M. Dubuc, President of the Agricultural Society of Rouen, that three measures of oats, pounded or broken up (concassées) and moistened, are equivalent, as aliment, to four measures given in the grain.

It is observed, also, that four parts of different kinds of forage, coarsely chopped, and deprived of dust, will go as far as five parts of the same forage given entire and separately.

There exists in Paris an establishment where mixtures of food are prepared, on this principle, for horses; it is that of M. Payen. The kinds most generally mixed are clover, and lucerne. They are then cut up, so that the horses are obliged to chew and masticate them in the most perfect manner.

The mixture of vegetables which is considered as the most suitable for draught horses, is composed of equal parts of cut straw, clover, and common hay. Barley and oats coarsely ground (concassées) and mixed, answer a better purpose than when eaten separately.

M. Dubuc visited this establishment, and found that the horses which worked the machinery, are fed in this manner, and that they look well and are vigorous, though kept at work ten or twelve hours a day. He cites also the teams of M. Sévin, mail contractor at Orleans, whose horses were fed on cut straw, mixed with one-fifth of clover and lucerne, and sometimes a little hay. They were fat, strong, and substantial. They give them also, Barley or oats crushed (concassées) and moistened. Care must be taken to place this food in deep mangers, so that it may not be wasted. Oats are frequently mixed with the last portions given them, prior to their being harnessed.

M. Dubuc was assured by both these proprietors, that there was a saving of one fifth at least, by this method, and that besides the horses were in better condition, and endured more labor than those fed on common unprepared materials.

The Omnibus establishments of Paris, which employ five or six hundred horses, have just adopted this improved food.—*Idem.*

STATISTICS.

1. *Academy of St. Petersburgh.*—The sixth series of the memoirs of this Academy commences at the centenary celebration of this learned body held in 1826. Up to this date, the complete collection of its volumes comprehends five series, each of which is marked by a change of title. From the foundation of the Academy in 1726 to 1803, the Latin language was the medium of communication. The first series, called *Commentaries* (commentarii) extended from 1726 to 1747, that is, from the inauguration of the Academy by the empress Catharine I, until the empress Elizabeth effected some new regulations. This series is in fourteen volumes. From 1747 to 1776 there are twenty one volumes of *Novi Commentarii.* The celebration of the semi-secular jubilee established a new epoch, from which the publications are called *Acta.* Twelve volumes of these bring the labors of the academy to the year 1783, a memorable year, in which the academy was placed under the direction of the princess Daschkoff, for in Russia there is no salic law even in the

government of letters and science. Under the new *directeur* (such was the title given to this lady by the Imperial Ukase which invested her with the direction of the academy) fifteen volumes of *Nova Acta* terminate the publications in Latin. The year 1803 was an important period to the Academy; the emperor Alexander gave it new laws, and the French language was substituted for the Latin. But the period was unfavorable to academic labors, so that from 1803 to 1826 but eleven volumes appeared, forming the fifth series, under the title of *Memoires*. Lastly, a mode of publication much more useful than that of entire volumes, viz. that of parts or livraisons, has been adopted, and which it is to be hoped will be followed by all learned bodies.—*Rev. Encyc. Aout*, 1831.

2. *Astronomical memoranda.*—The new observatory of Geneva has just been finished, and the instruments are soon to be placed in it. The transit instrument and the equatorial of Mr. Gambay are immediately expected, the pillars being ready for their reception. A detailed account of this new establishment is to be published in the Bibliothèque Universelle.

MM. Troughton and Simms are now engaged in constructing a grand equatorial, with an achromatic telescope of eleven inches aperture and eighteen feet focal distance, which Sir James South has obtained of M. Cauchoix. The axis of this instrument presents no inconsiderable difficulty on account of the deflection which may be apprehended from such dimensions. Mr. South has erected in his observatory at Kensington, a turret for the accommodation of this instrument under the direction of Mr. Brunel, the younger. The cupola is made of thin cedar boards, covered with copper; and notwithstanding its great dimensions, a weight of sixteen pounds will put it in motion, and a weight of twelve pounds will keep it moving.

M. Respold, fils, has just finished at Hamburgh a large transit instrument for the observatory of Edinburgh. It has been mounted and verified in the observatory at Hamburgh by Mr. Rumker, who is now the director of that observatory, having renounced the intention of returning to New South Wales. Mr. Dunlop has been appointed director of the observatory of Paramatta.

The celebrated astronomer Bessel was obliged to leave his observatory at Königsberg in the month of August last on account of the cholera morbus;—a hospital having been established on one side of the observatory and a cemetery for the victims of the disease on the other.—*Bib. Univ. Oct.* 1831.

Acknowledgments to Friends and Correspondents,

DOMESTIC AND FOREIGN.

Received.—Proceedings of the first annual meeting of the New York State Lyceum, held at Utica, August, 1831.

Rev. President DeLancey's address before the University of Penn. at the opening of the session of 1830—31.

Scientific tracts for schools, lyceums, and families, by Josiah Holbrook and others, 1829—30.

Col. R. Somer's Appeal on the subject of the Chenango Canal, 1830.

Academic Pioneer, Vol. I. No. 1, Cincinnati, 1831.

Report of Wm. M. Cushman, Engineer, upon a rail road between Albany and Schenectady, August, 1831.

Memorial of S. W. Pomeroy to Congress, on a revision of the Patent Laws—Gallipolis, 1832.

H. G. Spafford's Pocket Guide, along the line of the canals, 1825.

Wm. A. Alcott's Essay on the construction of school houses.

Dr. Felix Pascalis's Eulogy on the late Dr. S. M. Mitchill, 1831.

Major Henry Whiting's Discourse on the anniversary of the Historical Society of Michigan, 1831.

Dr. McAllister's Dissertation on Tobacco, 1832.

Dr. S. P. Yandell's Introductory Lecture on Chemistry, 1831.

Report of the managers to the Lehigh Coal and Navigation Company, 1832.

The Albany Literary Gazette, and Repository of Literature and the Arts, Dec. 1831.

Peter A. Browne, Esq. on the Geology of the site of Philadelphia.

Review of the project for a great Western Railway, by E. F. Johnson, Engineer.

Journal of the Philadelphia College of Pharmacy, Vols. II and III.

Prof. C. S. Rafinesque's Monograph of the fluviatile bivalve shells of the river Ohio, translated by C. A. Poulson, Philadelphia, 1832.

T. H. Taylor's address before the Charleston Infant School Society, 1831.

President Lindsley's Baccalaureate address, 1831, Univ. Nashville, and Address on Washington's birth day.

Two lectures on Political Economy, delivered at Clinton Hall, New York, Dec. 1831, by Wm. B. Lawrence, Esq.

Address of the Friends of Domestic Industry, N. York, Oct. 1831.

Remarks on the total abolition of Slavery, by a citizen of N. Y.

Questions and notes on Genesis by George Bush.

American Colonization Society, and the Colony at Liberia, Boston, 1831.

The Atlantic Journal and Friend to Knowledge, first number for the Spring of 1832, by Prof. C. S. Rafinesque.

Dr. Torrey's Catalogue of North American Genera of Plants, with Dr. Gates's collection of dried plants from Louisiana, &c.

Young Mechanic, Boston, 1832, No. 1.

The Ladies' Magazine, Jan. 1832.

Dr. L. C. Beck's Manual of Chemistry, 1831.

Dr. J. L. Comstock's Elements of Chemistry, 1831.

" " System of Natural Philosophy, 1830.

J. W. Barber's History and Antiquities of New Haven, 1831.

Chancellor Kent's Commentaries on American Law, 4 vols. 8vo. 1826—1830.

Thomson and Cowper's poetical works, &c. republished by J. Grigg, Philadelphia, 1831.

Fifteenth Annual Report of the American Colonization Society, Washington, 1832.

Annual Report of Prison Discipline Society, 1831.

" " American Education Society, 1831.

Tenth Annual Report of the Board of Canal Commissioners, in Ohio, 1831.

First Annual Report of the N. York Young Men's Society, 1831.

Fifteenth Report of the Directors of the American Asylum for the Deaf and Dumb at Hartford, May, 1831.

Mrs. Somerville's preliminary dissertation on the Mechanism of the Heavens, republished by Carey & Lea, Philadelphia.

De La Beche's Geological Manual, 1832. Carey & Lea.

Sir H. Davy's Salmonia, 12mo. 1832. Carey & Lea.

Dr. Lardner's Cabinet Cyclopædia, Vol. 14,—Silk Manufacture, 1832. Carey & Lea.

Dr. James Johnson's Change of air, or Philosophy of travelling, republished by S. Wood & Sons, New York, 1831.

Report of the Royal French Academy of Medicine, to the Government, on Cholera, translated by Dr. J. D. Sterling, and republished in New York by S. Wood & Sons, 1831.

Three lectures on the rate of wages, by N. W. Senior, of Magdalen College, late Professor of political Economy, 1830.

A statement of circumstances, connected with the late election for the presidency of the Royal Society of London, 1831.

On the alleged decline of Science in England, by a foreigner, London, 1831.

Observations on the state of Historical Literature, &c. by N. H. Nicholas, Esq., London, 1830.

Refutation of Mr. Palgrave's Remarks in reply to observations on the state of Literature, &c. by N. H. Nicholas, Esq., 1831.

Short and plain rules for the prevention and cure of cholera morbus, intended for unprofessional readers, by Gideon Mantell, F. R. S. 1831.

Prof. Babbage's Logarithmic Tables, London, 1831.

Report of the proceedings of the Portsmouth and Portsea Literary and Philosophical Society, 1830—31.

History of Lewes, England, 2 vols. 4to. by G. Mantell, Esq. and Rev. T. W. Horsfield, 1824—27, Lewes.

Narrative of the visit of King William IV and Queen Adelaide, to Lewes in Oct., 1830, 1 vol. 4to., London.

Dr. Wm. Henry's estimate of the Philosophical character of Dr. Priestley, 1831.

List of the members, and minutes of the doings of the London Geological Society during 1829—30.

Des Machines de leur influence, &c. Paris, 1831.

Annales de L'Institute Royal Horticole de Fromont, 1831.

Mining Review of London, 1831.

Recueil industriel, manufacturier et des beaux arts, pour l'anne 1831.

Bulletin de la Soc. Française de Statistique Universelle, 1830–31.

Annales de L'Industrie, Paris, 1830—31.

Montague's Ornithological Dictionary, by James Rennie, M. D. &c. London, 1831.

Experimental Inquiry on light and colors, and the source of color in the prism, by Walter Crum, Esq. of Glasgow, 1830.

M. Alexander Brongniart, Tableau des terrains du globe ou Essai sur la structure, &c. 1829.

M. Alexander Brongniart, Classification, &c. des roches, 1827.

" " Des Volcans et des Terrains Volcaniques, 1829.

Jern-Kontorets Annaler, Stockholm:—a periodical Scientific work, 12 vols., from 1821 to 1829.

Kongl. Vetenskaps-Academiens Handlingar, för 1829 och 1830. Stockholm.

Arsberättelser om Vetenskapernas Framsteg, afgifne af Kongl. Vetenskaps-Academiens Embetsmän, för 1829 och 1830. Stockholm.

Supplement to the Encyclopædia Britannica, 6 vols. 4to. from John Dunlap, Esq. of Edinburgh, for Yale College Library, 1824.

With a few exceptions, we have omitted to mention Journals, whether foreign or domestic, received in exchange; and among numerous foreign Journals of Science and Literature, which arrive more or less regularly, we have named only those which have recently begun to come, or which have been revived, after a discontinuance.

For want of time and space, we must omit any remarks which we might, otherwise, be disposed to make on some of the publications named above, and for the present can only make our acknowledgments (in some cases too long delayed) to authors, editors, publishers, and others, who have been so kind as to forward them to us.—*Ed.*

THE

AMERICAN

JOURNAL OF SCIENCE, &c.

Art. I.—*On the Water Courses, and the Alluvial and Rock Formations of the Connecticut River Valley;* by Alfred Smith.*

I. Connecticut River.

Sources and course.—Connecticut River rises on the southern slope of the Highlands which divide the United States from Lower Canada, where its head waters form a lake, three miles in length, which in recent times has received the name of Connecticut. The surface of Lake Connecticut, is about one thousand six hundred feet higher than the level of Long Island Sound. The ample mill stream which dashes over the rocky outlet of this lake runs towards the southwest, falling about six hundred feet in the first twenty five miles of its course. The river then turns to a more southerly direction. Winding its way through frequent meadows, it passes by Lancaster, N. H. to the head of the Fifteen mile falls, which consist of a succession of rapids with a descent of three hundred and fifty feet in twenty miles. The base of the White Moun-

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* Mr. Smith, the author of the annexed article, has, within a few years, carefully investigated the topography of the great valley of the Connecticut. This investigation, was undertaken on behalf of the inhabitants of the valley, with a view to the improvement of the navigation of the river; it was continued during several successive seasons, and led to an extensive and precise knowledge of the physical features of this great and important region.

Mr. Smith, having been requested to embody his observations on the geology and topography of the valley, has written the annexed account, which, with the aid of drawings on a large scale, (those now published are greatly reduced copies,) has been recently read in the city of Hartford, as a part of a course of popular lectures which is sustained there, during the present season, by gentlemen of that place, who contribute their personal efforts to this laudable purpose.

It has not been thought necessary to alter this essay from the form which it received, as a popular lecture.—*Ed.*

tains extends to the river, along the Fifteen mile falls, now one hundred yards broad, and pushes its channel twenty miles towards the west. Thence the river proceeds in a more southerly direction two hundred miles, where it is met by tide water at the foot of Enfield falls, twelve miles above Hartford, and is three hundred yards in width. From the head of tide water the river continues, thirty miles, to Middletown, where suddenly changing to the southeast, it pursues its new course thirty miles farther to Long Island Sound.

Falls and rapids.—The other principal falls and rapids are the White River Falls, at Hanover, N. H. with thirty six feet of descent; Bellows Falls, near Walpole, fifty feet; Miller's and Montague Falls, seventy feet; Hadley Falls, at South Hadley, Ms. fifty feet; and Enfield Falls, thirty feet. These added to intervening smaller rapids, make a total descent of nearly four hundred and fifty feet between the foot of the fifteen mile falls and tide water.

Length.—The length of Connecticut River, measuring all its windings, is four hundred miles. The length of its valley, avoiding the smaller curvings of the stream, is over three hundred miles.

Navigation.—Coasting vessels ascend the river, fifty miles, to Hartford. Boat navigation, by the aid of locks at Enfield Falls, Hadley Falls, Miller's and Montague Falls, Bellows Falls; a small rapid called Quechy Falls; and White River Falls, extends two hundred miles above tide water.

II. Valley of Connecticut River.

Width.—The valley of the Connecticut, embracing within that term all the tract of country from whose surface rains and streams flow into Connecticut river, has a very irregular boundary and unequal breadth. The courses of the bounding summits are easily traced upon the map. The breadth of the valley, from the eastern to the western summit, measured on parallels of latitude, is, at Lake Connecticut, twenty miles; at the Fifteen mile Falls, fifty miles; at Haverhill, N. H. twenty five miles; at Orford, N. H. and across the sources of the tributary White river, fifty miles, ten miles of which lie east, and forty miles west of the Connecticut. From the north to near the south line of Massachusetts is the widest part of the valley, averaging fifty five miles. At Hartford the breadth is thirty two miles, at Middletown about twenty miles, and thence the valley narrows to the mouth of the river. The widths stated, being measured in straight lines, upon the map, are much less than the length of the tributary streams which flow from corresponding portions of the valley.

Water courses.—On one side of the bounding summits of the valley, rains and springs and rivers flow into the Connecticut. From the opposite sides of the same summits, they flow away through other channels. Beginning at the north, the St. Francois river rises by the sources of the Connecticut, and empties into the St. Lawrence. At the east, very near the sources of both the Connecticut and St. Francois, heads the Margalloway river, which lower down, takes the name of Androscoggin, and passes through Maine, to the Atlantic. The Connecticut river valley increases rapidly in width, below the parent lake, and on the east side forms the upper and lower Ammonoosuck, and between these, Israel's river. The White Mountain range then stretches towards the west, making room, on its southern slope, for the sources of the Merrimack river, whose tributaries carve deeply towards the Connecticut, from a tract of country extending down one hundred miles, nearly to the north line of Massachusetts. There the valley of the Connecticut again opens, and forms, first Miller's river, forty miles in length; and below, the Chickopee, the largest tributary of Connecticut river. In the southern border of Massachusetts the valley again becomes narrow, and so continues into Connecticut, leaving place for streams, which flowing to the east and south, are discharged through the Thames river at New London.

Returning to the head waters of the Connecticut, on the west rise the Clyde and Black rivers, which passing through Lake Memphramagog, unite with the St. Francois. The valley of the Connecticut, south of the heads of the Black river and the Clyde, opens broadly on the west side, and collects the waters of Pasumpsic river, a large tributary, which passing south, meets the Connecticut at the foot of the Fifteen mile falls. Next on the exterior slope, the sources of the La Moile and Onion rivers rise within ten miles of the Connecticut, and flow towards Lake Champlain. Below, White river drains a broad tract of country into the Connecticut, supplying more water than any tributary, except the Chickopee. Farther south, on the exterior slope, rises the Otter Creek, and runs northwardly, to Lake Champlain. Below, within the valley of the Connecticut is formed West river, which runs to Brattleborough, and proceeding south, Deerfield, Agawam, and Farmington rivers, complete the number of large tributaries, and respectively unite with the Connecticut, at Deerfield, West Springfield, and Windsor. Below the heads of

Otter Creek, on the west side of the dividing summit, rise the sources of the Battenkill and Hoosack, emptying into the Hudson, and lower down, the heads of Housatonick river, which runs south into Long Island Sound.

Boundaries.—The west side of the Connecticut river valley, is chiefly bounded by the summits of the green woods, in Connecticut and Massachusetts, being the same range of Highlands, which, under the name of Green Mountains, forms the boundary in Vermont. About the forty fourth degree of north latitude, the Green Mountains divide and proceed northerly in two ranges. The eastern and less elevated range, which at the wide spread sources of White river is forty miles from the Connecticut, curves around the heads of that tributary, to within nine miles, at Newbury. Its continuity being unbroken, the eastern range forms the dividing summit of the waters flowing into Connecticut river on one side, and lake Champlain and the St. Lawrence on the other. The western and more elevated division of the Green mountains, with peaks and ridges four thousand feet high, alternately descends and rises, first to afford a passage to the Onion river; then for the La Moile; and again for the Misisque. The principal mountains in the dividing summit on the east side of the Connecticut, are the White Mountains, and the grand Monadnok, both in New Hampshire.

Mount Washington, in the former range, is six thousand two hundred and fifty feet above the level of the sea, and is the highest land between the Atlantic Ocean and the Rocky Mountains. The most elevated ground, lying wholly within the valley, is Ascutney mountain, at Windsor, Vt. which is three thousand feet high. Above the north line of Connecticut, the best and least elevated thoroughfares across the dividing summits, both east and west, rise from eight hundred to one thousand feet above the level of the sea.

Face of the country.—To the eye of the traveller passing along the banks of Connecticut river, plains and meadows appear to occupy a large proportion of the valley. The nearest range of hills, especially north of Greenfield, Ms. conceals the more distant ranges. But plains and meadows possess, comparatively a small part of the region which is drained through Connecticut river. Whether proceeding to the east or west, hill is found rising above hill, and valley formed beyond valley, each contributing to supply and enlarge the waters of the Connecticut.

Descent of the tributaries.—The abrupt and mountainous character of so large a part of the valley, causes floods to be sudden and currents rapid, in the tributary streams. In many tributaries, the descent averages, thirty, forty, sixty, and in some more than one hundred feet in a mile. On the White Mountains is seen a small, clear, icy looking lake, five thousand feet above the level of the sea. It is the highest source of the lower Ammonoosuck: the stream which issues from this lake falls four thousand feet in about two miles. It is but just perceptible, except during or after violent rains, when it is seen bounding from rock to rock in its downward course, sparkling and white, as if a snow drift had been dashed against the dark side of the mountain, from its summit to its base.

Lakes.—About two hundred small lakes, from less than one mile to two and three miles long, lie scattered over the mountainous surface of the Connecticut river valley, placed, almost without exception, at or very near the sources of tributary streams. The Mascomy lake in Lebanon, N. H., is seven miles long, and the Sunapee, the largest in the valley, is about twelve miles. The latter lies so near the centre of the dividing ridge, that a channel, excavated to no excessive depth, would change the course of its stream and turn it away from Connecticut river into the Merrimack. As the extent of country drained near the sources of streams is small, the quantity of earth collected in such positions is also small, and has not yet filled the rocky basins, where lakes remain. But following the courses of the tributaries farther down, small meadows appear, many of which, doubtless, occupy the places of former lakes, whose basins have been filled by depositions of earth, collected and washed down in the now longer courses and multiplied branches of the stream. Augmented currents may, also, have worn deeper the channels at the outlets, and drained the lower lakes, leaving their beds uncovered which soon become clothed with vegetation.

III. Earthy Formations.

Depth of earth.—Along the Connecticut, and often near its tributaries are plains and meadows so level that the eye can hardly discover the smallest declination in their surface. But by far the greater part of the valley, probably nine tenths, presents a surface perpetually changing, rising and falling with every variety of steepness, from the most gentle undulations, to abrupt mountains and perpendicular cliffs. These inequalities and changes of form are not to be ascribed to the loose earth, the gravel, sand, clay and loam which overspread the surface. In seven eighths of the valley an excavation to the depth of a common well, would penetrate the solid rock. The thickness of superficial earth and soil, compared with the known height and depth of rock beneath, is as the thickness of a sheet of paper on the roof, to the height of the loftiest edifice. At the top, and sides, and bases of the highest mountains, the rocky strata are frequently exposed to view; and in ravines, the beds of rivers, and artificial excavations. At Montpelier,* the rocky strata by the Onion river have lately been perforated to a depth of eight hundred feet in search of salt water, and in mines and quarries of other countries, to a much greater depth. The Alps and Andes, and all the high mountains of the earth shew their rocky frame work on their summits, and at numerous intermediate points from thence to their bases.

Ingredients of earth and rocks similar.—Is the thin covering of soil and earth which overspreads the rocky strata, an original production of creating power, or only fragments and ruins, which convulsions, and time, and the elements have severed and decomposed from an originally rocky surface? At the top is found a slight covering of soil, manifestly a product of vegetable decomposition. Beneath the soil are sand, clay, loam, fragments of rock, in a state of confused mixture, on hills and mountains; and in plains and meadows, arranged with order and exactness. Now the common sand is but pulverized and water worn siliceous stone, the quartz of granite and other rocks of the solid strata. The materials of clay abound in the feldspar of granite rocks, and in numerous slaty ledges. The isinglass, whose glittering in the sand attracts the eyes of children, is the mica of granite and other related rocks, on one form of which we daily walk over the mica slate paving stones brought from Bolton. The solid strata also contain every variety of materials, combination, and arrangement found in pebbles and fragments.

Marks of fracture in rocks.—Not only do the rocky strata contain all the ingredients which exist in sand, clay, gravel, loam, and all the combinations of materials found in pebbles and fragments, but countless numbers of large fragments scattered over many thousands of square miles, above and beneath the surface of the ground, retain the plain marks and forms of forcible disruption. When the

* There is no reason to expect to find salt in any country whose geological character is like that at Montpelier.—Ed.

trunk of a tree has been cleft in twain, no eye is so unpractised as not to distinguish between the surface of the cleft, and the natural surface of the bark or the wood under the bark. When a limb has fallen from a forest tree, every one knows, at a glance, that it has been rent and fractured, whether the severed limb remains or has been removed. The structure and natural surfaces of rock lie less open to common observation than the growth and cleaving of trees. Yet who that inspects the unhewn blocks collected for chisselling by the stone cutter, does not perceive in their rough, irregular and angular surfaces, that they have been broken by force from some larger mass? So in the quarry, every one judges that the blocks before him have been rent and severed by violent means. Indeed in all situations, rocks recently broken present, to the most common observation, ample proof of such fracture. Of fragments which have long been broken up, some fall into water courses, where they are smoothed and rounded into pebbles. Some remain upon the surface of the ground, and according as they are softer or harder, lose more or less of the sharper edges and the freshness of recent fracture. Their surfaces may have crumbled and become covered with lichens or moss; yet in many, especially such as have long been protected from decay by a covering of earth, may still be seen the peculiarities of form, the rising, sinking, angular, ever varying surface, which, in a large proportion of rocks, characterize forcible separation and fracture.

The vicinity of Hartford, from the extent of the alluvial formation, does not abound with fragments such as have been mentioned. But the surface of the country, for many miles around the White Mountains, is covered with countless masses of dislocated rocks. In ascending Mount Washington, the visiter steps upon them, he sees them on all sides; and finds at the summit many acres of huge fragments, broken, piled, and lodged against each other, without tree, or shrub, or herbage to obstruct his view. He walks between and beneath them, among interstices unfilled with earth or soil. Lichens have fastened upon the surfaces, and mosses grow in the deep recesses of the rocky fragments. The rocks are granite of exceeding hardness. Time, even in the cold temperature of those elevated summits, has indented and grooved some less enduring portions of the rock. But the marks and features peculiar to broken rocks, the rising, sinking, angular, ever varying forms, remain as manifest on the surface of the huge fragments of those mountain tops, as in the quarry, or the unhewn blocks collected for the stone cutter.

Earth was once rock.—It is not, however, on the White Mountains only, but over a large part of the mountainous and hilly portion of the valley, that proofs of a violent and extensive disruption of the rocky strata are visible. This is particularly the case in the upper half of the valley, as well as near the dividing summits of the lower half. Rapid currents and consequent attrition, having worn and rounded vast numbers of fragments into pebbles, some of them now form the beds of rivers; others have been left on elevated dry ground, by the changed courses and deepened channels of the streams in which they were smoothed and polished. But in crossing the valley from east to west, and in ascending towards the sources of Connecticut river, innumerable rocky fragments may be seen retaining clear marks of forcible disruption, not only on the surface of the ground, but more plainly where roads and excavations disclose loose rocks which have been long protected from decay by a covering of earth. It is believed that after careful and extensive observation, few persons could doubt that the rocky fragments which lie scattered above and below the surface of the ground, were once combined in larger masses, probably united in solid unbroken strata, similar to those which are often seen uncovered on the sides of hills and mountains. When it is farther considered that the component parts of primitive rock, although not commonly transparent, are crystalline in their structure; that the quartz, the feldspar, and mica of granite and other rocks are as truly crystals, as those produced before our eyes by evaporating a solution of salt, copperas, or alum; that the materials of sand, gravel, and clay, are the same as the component parts of crystalline rocks; it is highly probable, that the now remaining solid rock, and the fragments, pebbles, sand, clay, and loam, were all once united in unbroken strata, the product of general laws of crystallization and union, established by Providence to accomplish the work of creation. The crystalline rock, also, in order and evidence of design, is as superior to the confused aggregation of loose earth upon the surface, as are the finished productions of the artist, to the chips and filings which have been removed in the progress of his works; or as the living tree, with its roots, and trunk, and branches, and foliage, and system of vessels, and circulating sap, is superior to the dead and decayed substance of the same tree, after it has been converted into soil. To prepare a world composed of rock for human habitation, it was necessary that its crust should be broken up, to produce more speedily the requisite covering of earth; just as it was necessary that the beauty of plants and trees should perish and decay, to fertilize, by a vegetable soil, the otherwise sterile ground.

It would be fruitless to inquire by what means the superficial solid strata were broken into fragments. Whether the familiar laws of expansion by heat, and contraction by cold, were agents in breaking up the rocky surface, or whether this effect was produced by other means, will probably never be ascertained.

Soil and vegetation.—The process by which rocks in fragments, and to some extent in the unbroken strata, become decomposed and acquire fertility, is sufficiently obvious. Those fragments which remain upon the surface, belong to the harder kinds of rock. Heat and cold, and moisture, gradually abrade their surfaces. First, the feebly vegetative lichen, of inferior organization, takes root, spreads, and dies; and falling off carries with it a small portion of disintegrated rock. In process of time the interstices of accumulated fragments become filled, and the fragments themselves are wholly decomposed, or buried in earth formed from their own ruins. Ferns and grass and trees succeed to lichens, in due order, propagating and increasing according to laws established by the great Architect, until full forests and verdant fields perfect the work, and complete the beauty of the vegetable world. Volcanoes may burst forth, and pour over the surface the melted substance of interior rocks: floods may deluge the world, disarranging and bearing away the accumulated earth and soil of ages; but the silent processes of decaying rocks and advancing vegetation recommence; the ravages of fire and flood are obliterated or obscured; verdure, and flowers, and fruits reappear; and whilst heat and cold, and moisture, and rocks remain, this progression will continue.

Such, it may be believed, have been, substantially, the progress and changes which have contributed to bring the valley of the Connecticut to its present state. The more fragile rocks decayed rapidly, until protected by a covering of earth formed over them. The harder rocks decomposed slowly, and when elevated to a temperature almost freezing in summer, many centuries would elapse without producing any considerable changes. Hence, on the summits of the White Mountains, the marks of fracture on the rocks are so little defaced; and ages must yet elapse before those piles of moss-covered fragments will crumble away, or be even perceptibly diminished.

IV. Alluvial Formations.

Plains and meadows.—The surface of the shallow covering of earth upon hills and mountains, presents the form and pressure of the rock beneath. The earth lies mingled without apparent order or uniformity of arrangement. But in the valleys of the tributary streams, and on a larger scale in the central valley of the Connecticut, long continued accumulations have formed extensive plains and meadows, the product of alluvial deposition and subsidence. Such plains and meadows are found at Lancaster, N. H. Along the Fifteen mile falls, hills press more closely upon the river, alternately diminishing and excluding alluvial formation. Below the Fifteen mile falls the hills recede, and admit the broad meadows of the great and little ox-bow, and the plains of Haverhill and Newbury. At White river falls, thirty miles lower, and at several intermediate points, rocky spurs close upon the river, which proceeds to its mouth through alternate meadows, plains, and hills.

In common language, the higher alluvial is called plain; the lower, meadow, particularly when within the reach of inundations from the river. The similarity of their external appearance and internal arrangement indicate that they have been formed by similar causes, throughout the whole length of the valley.

Arranged in terraces.–The plains and meadows are generally so level, that their declination is not perceived by the eye. Three distinct terraces of plain and meadow, in some portions of the valley four, rise to various heights, from fifteen or twenty to two hundred feet, above the surface of the Connecticut. The upper terrace of plains extends to the hills whether near or distant, and rests against their sides. The faces of plains towards the river are generally formed into sweeping curves, and slope with a regular descent, to the level next below. Some of the plains may be traced from one great fall in the river to another, twenty or thirty miles, disappearing where projecting spurs or other local causes prevented their formation, or the subsequent action of the river undermined and removed them. A spectator standing on the upper plain, and looking across the river, may commonly see portions of a similar plain, of corresponding height, terminating against the opposite hill sides. The angle at the brow of the plains, and the steep and regular descent down their faces, though not the same in all, are perfectly distinguishable from the angles and curving slopes of hills and mountains. The lower plains and the meadows, are seen in like manner, in corresponding levels, on both sides of the river.

On alternate sides of the river.—In some places the river divides the meadow, leaving a part on either side. Next, the meadow lies wholly upon one side, whilst, on the other, the river washes the foot of the lower plain, which farther on disappears, in turn, and the river there flows at the foot of the higher plain, as at Cooper's rocks below Brattleborough, the hour-glass at Windsor, above Water Quechy falls, and at many other places, where the sands roll from the brow of the plain into the water, from heights of one hundred and one hundred and fifty feet. Soon the river is seen winding towards the opposite hills, the lower plain reappears, then the meadow, which at last is found wholly upon that shore where there was no meadow, half a mile or a mile above.

By subsidence.—The interior composition and arrangement of the numerous plains is very similar, especially in their frequent beds of clay, which are twenty, thirty and forty feet in height. They are composed of successive layers, commonly from a third to half an inch in thickness, and lying in nearly a horizontal position, wherever they have not been undermined and bent by local causes. The layers of clay beds are in fact composed of clay and quick-sand. The order in which the materials of each layer are arranged is invariable, and may be most distinctly seen wherever the clay is highly colored. At the bottom of the layer is the coarsest, heaviest, and least colored portion of the sand. In the center is the finer sand, with an intermixture of clay and deeper color. The top of the layer consists of the finest clay, and is the most highly colored. Beds of clay, consisting of fifty, a hundred, and even more such layers, are found in plains, and sometimes passing under the river, in extensive portions of the valley. This uniform arrangement of materials in the layers may be reproduced by dissolving and blending them, and suffering them to subside by their own gravity in water. During the last summer, similar layers, though of greater thickness, were found to have been formed in the canal at Enfield falls, out of materials washed by rains from contiguous clay hills, within the last two years. No method is known, except that of subsidence in water, which will produce the same distribution and arrangement of materials that exists in the layers composing clay-beds. The more sandy portions of the plains and meadows, also exhibit proofs of successive depositions, in changes from coarser to finer, and occasional stripes of color, indicating that they, like the clay-beds, have been formed by diffusion and subsidence of their materials, in water. Other and generally sterile plains have doubtless been formed by a more sudden process, and more violent action of water.

In ancient lakes.—The facts which have been stated must lead the way in accounting for the formation of the plains arranged in layers, situated so far above the highest inundations of the river. No one, who considers the power of currents and falling water, will maintain that Connecticut river has not lowered its bed, during a lapse of several thousand years. At some former period, a chain of lakes must have possessed the centre of the valley, connected by streams falling, as now at the rapids of the river, or more abruptly, from the level of higher lakes, to the level of others below. The elevation of the lakes was at least as great, in different divisions of the valley, as that of the existing plains in the same divisions. The hills which press upon the water's edge, on either side of the Connecticut, at White river falls, were probably, at some former period, united by an unbroken ledge of rocks, which lying across the present channel, formed the lower brim of a long basin, and sustained the waters of a lake reaching to the Fifteen mile falls, of varying width, corresponding with the distance of the hills which formed the boundary on opposite sides. At Bellows falls was, probably, another rocky barrier, sustaining a lake thirty five miles long, extending to White river falls. Similar barriers existed below, probably one near Brattleborough, and others in succession, as far down as Middletown, below which the higher plains disappear from the course of the river.

To raise a lake above the existing plains, the supposed barrier at White river falls, must have been more than two hundred feet higher than the present surface of the water at the same place. Such a barrier would have elevated the water above and beyond M'Indoo's and Dodge's falls, and half way up the Fifteen mile falls, giving to the lake a length of thirty five or forty miles, and an average breadth of about two miles. The well known ox-bow meadows, and the plains of Haverhill and Newbury, occupy nearly a central position in the basin of the lake described. North of this center, the Connecticut river valley is one hundred miles in length, and from twenty to fifty miles broad, embracing a superficial extent of more than three thousand square miles. Over this surface fragments and rocky strata have been decaying thousands of years, and the finer earth produced by such decay, has been carried down by rains and floods, and diffused in the first large lake of the Connecticut. Some part of the materials thus accumulated then subsided, and compose the present plains and meadows of that basin. Other portions were borne through the lake, and over its rocky barrier, contributing to the plains of lower basins, or passing onward to Long Island Sound; as is seen at the present day, in the turbid waters of our annual floods. A proof as well as consequence of such a mode of accumulation, exists in the general fineness of the earth, of which plains and meadows are composed. Loose rocks and fragments are no more frequent than may be accounted for, by tributary streams thrusting forward the coarser contents of their beds, or outbreaking in new channels—the falling of insulated peaks, such as are seen cutting through and rising above the plains—and occasional transportation of rocky fragments, by ice floating from the hill sides.

The lakes become a river.—It may be inferred, from the level surface of the plains, that the lakes in which they were formed were filled with earth before, perhaps long before, the barriers gave way—that the lakes disappeared, and a river flowed through the full plains, wearing away on one side, and casting up the earth in eddies on the other, as at this day among the meadows—that what is now the plain was once meadow. Hence the sweeping curves and regular slopes of the faces of the plains. When a barrier gave way, the river would deepen its channel throughout the whole extent of such a plain. There is no such thing in nature as a rapid stream, running upon a bed of clay or sand. Currents seize the finer earth with which they come in contact, bearing it along, until thrown aside into some eddy, or meeting with other tranquil waters, it is again deposited. Hence when, by the breach of a barrier, the river took possesion of a deeper bed at the outlet of the basin, its channel through the whole extent of alluvial plain, would be deepened in like proportion. Thus the lakes disappeared, leaving Connecticut river in their stead.

Action of the river.—During the formation of its deeper channel, the river acquires new power of undermining and wearing away its banks, as yet unprotected by turf or trees. At Northampton and Wethersfield, the Connecticut within the memory of man, has removed its bed eighty rods, by wearing down the banks on one side, and throwing them up in eddies on the other. Similar laws of action operated in ancient times, and on the levels of the plains. In this manner were probably caused, not only the sweeping curves and regular slopes, but the various distance, and occasional disappearance of the higher plains, on opposite sides of the river.

Summary.—Thus rocks have been converted into sand and clay—currents have swept along the prepared materials and deposited them in layers—successive breaches of the barriers lowered the bed of the river to corresponding depths,—the river in its new channels rearranged the sand and clay into lower plains, and finally in meadows. The remains of these progressive and various changes, constitute the alluvial formations of the Connecticut river valley.

V. Primitive Rock.

It must be perfectly understood, that the whole superficial covering of earth on hills and mountains, as likewise the alluvial formations, rest upon a sub-stratum of solid rock. Diversity in the substance, arrangement and coherence of the component parts of rock, have led to their division into classes. The primitive class is distinguished by being purely mineral, and semi-crystalline. In general it contains no fragments of rock, and no remains of vegetable, animal, or marine productions. From the sources of Connecticut river, to the north line of Massachusetts, all the rocky strata belong to the primitive class, and generally, the sides and summits of the valley to Long Island Sound.

VI. Secondary Formation.

Locality.—In Northfield, near the northern boundary of Massachusetts, rocky strata appear, diverse in several particulars from rocks of the primitive class. They are composed of fragments, pebbles, gravel, sand, clay, lime and other ingredients of primitive rock, reunited in strata by an invisible cement. They are not purely mineral, like the primitive, but contain remains of plants, fishes, and animals. The color of the strata is commonly red or brown. From the manner and materials of their composition, rocks of this class are denominated a secondary formation, sometimes a sandstone formation. Beginning at Northfield, the border of the secondary formation may be traced, east of the river, in Montague, Sunderland, Amherst, Granby, Ludlow, Springfield, Wilbraham, Mass., and Somers, Ellington, Manchester, Glastenbury, and Chatham, where crossing Connecticut river, the eastern border proceeds through Middletown, Durham, and East Haven, to Long Island Sound. The western margin of the sandstone formation passes from Northfield into Bernardston, Greenfield, Deerfield, Whately, Hatfield, Northampton, Southampton, Westfield and Southwick, Mass., and in Connecticut, into Granby, Simsbury, Farmington, Southington, Cheshire, and thence to the Sound, near New Haven. Similar rock is seen in frequent ledges and quarries, in the beds of tributary streams, and is excavated from wells. It rises in Sugar loaf mountain, in Deerfield, and other heights in that town and Sunderland, six hundred and seven hundred feet above the level of the sea. Connecticut river enters the secondary formation at Northfield, runs over its uncovered strata four miles, at Miller's and Montague falls; an equal distance at Hadley falls, thirty miles below,—and five miles at Enfield falls, still twenty miles lower. After running eighty miles in the sandstone basin, the river suddenly leaves it at Middletown, and passes thirty miles to the sound in a southeastwardly direction, ending, as it began, in the primitive formation.

Extent.—The length of the secondary basin, from Northfield to New Haven, exceeds one hundred miles. Its breadth expands to sixteen miles, through the northern half of Connecticut, and the whole superficial contents are about one thousand square miles. The depth of this formation must be chiefly conjectural. It has been perforated, at South Hadley, to depths of eighty and one hundred and forty feet, in a fruitless search for coal. It rises six hundred feet above the surrounding meadows, in Deerfield and Sunderland. Supposing the secondary to be formed above, and to repose upon the primitive, the latter is probably uneven with hills and valleys. In passing transversely towards the summits of the primitive mountains of the valley, the rate of ascent is diverse, five hundred or one thousand feet, and sometimes much more, in a distance of six or eight miles. If the primitive rises at similar rates under the secondary formation, the latter is in some places five hundred and one thousand feet deep, and in some it may be much deeper. That the secondary was formed in a basin of the primitive, and rests upon it, is apparent from its manifestly later formation; from the primitive rising and extending above and beyond the borders of the sandstone; and also penetrating it in isolated peaks or ledges, as may be seen a few miles west of Hartford.

The organic remains of this secondary formation consist of several varieties of fish, found at Sunderland, imbedded in the rock and fossillized. At Enfield, Hadley, and Montague falls, and other places, are found limbs of trees and fern like plants, also imbedded in the solid strata. In excavating a well in East Windsor, animal* bones were found twelve feet below the surface of the rock, perfect in color, form and substance. It is evident that before the red rock basin was formed, the crust of primitive rock had been broken up, and variously changed to pebbles, gravel, sand, clay, and all the variety of mineral substances and forms found reunited in the secondary. Fishes also lived in the waters, and trees, plants, and animals on land.

Layers.—The secondary rock is formed in layers, one over another, differing in thickness from a few inches to several feet. The division into layers may have been caused by occasional deficiencies of the cement; or, more generally, by the uncohering nature of the substances which were deposited and came in contact, at the surfaces of separation.

Plates.—In many places the layers are manifestly composed of successive thin plates, which often separate with the application of moderate force. The place of separation is distinguished by difference of color and materials, or by change from coarser to finer. The distinction of thin plates in the secondary strata is as manifest, and frequently of the same kind, as in the clay beds before described. A sandstone layer, a foot thick, will often split into twenty or thirty plates, each similar to the others, in materials and arrangement, indicating that a uniform law controlled the formation of the whole.

Distribution of the ingredients.—The larger fragments and pebbles are chiefly found around the borders of the secondary formation. They have been traced and are abundant on the eastern margin of the secondary strata, in every town from Northfield to Chatham. In the more central parts of the red rock basin, the rocky strata are generally composed of very fine materials. In recent excavations of not less than fifteen thousand cubic yards of rock, at Enfield falls, at numerous positions along an extent of several miles, the materials of the rock were so uniformly fine, that a fragment or pebble as large as an acorn, is not known to have been met with. Such is also the general fact in the excavation of wells at Hartford, Suffield, and other towns situated centrally in the secondary, and in the bed of the river at Hadley falls. Some cause of extensive influence must have occasioned the existing distribution of coarse materials around the borders, and fine in the central portion of the secondary formation.

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* A vertebral animal.

Dip.—The position of the secondary strata is rarely horizontal. The dip is more generally 10° or 12° to the east or north east, but is not uniform in direction or quantity. At Hatfield, the strata are seen dipping to the north west or west, and at Montague falls, they stand almost perpendicularly, forming an angle of 75° and 80° with the horizon.

Causes of the secondary formation.—Are natural causes and agents adequate to account for the formation of the secondary rocks, including the accumulation of the materials—their arrangement in parallel layers, and of the layers in similar plates—the distribution of coarse ingredients around the margin, and of fine near the center of the basin—the pervading color—and the cement which has converted an aggregation of previously dissevered substances into solid strata?

Of plates and layers.—Every kind and combination of mineral substances, found in the component parts of the secondary formation, may also be found in the primitive strata. The disruption of the primitive crust, and the process by which pebbles, gravel, sand, clay, and every species and mixture of fine earth were probably produced, have already been described. The sandstone rock was doubtless the first formation which took place, after the disruption of the primitive, and the alluvial meadows are the latest. When the primitive strata were broken up, a vast amount of fragments and of rocky surface was exposed to the power of disintegrating agents, heat, cold, and moisture; and the decomposition, and consequent production of fine earth, were proportionally rapid. At the commencement of the secondary formation, the whole surface of the valley would supply materials, which would be accumulated in its deeper and more central parts. When the new formation had spread to its ultimate limits, the materials of subsequent layers were supplied from the uncovered surfaces of the primitive, above, and at the sides of the secondary. In the course of time, floods and currents would accumulate an amount of materials equal to the whole contents of the secondary basin. To distribute those materials in their existing positions and order—to arrange successive plates into layers, and by successive layers to raise the surface to its final elevation—and to diffuse the coloring matter and cement, would require the presence of a lake or bay, at least coextensive with the secondary formation. Such a lake or bay must have extended from New Haven to the northern boundary of Massachusetts.

Distribution of coarse and fine materials.—In the lake or bay supposed, the heavier fragments and pebbles, brought within its limits by successive freshets, and by long continued currents, would subside near the borders. The finer materials, sand, clay, &c. would be diffused, by the force of floods and currents, and the agitation of winds and waves, and gradually subside, in the order required by the laws of gravitation. Successive supplies of similar materials, driven by like currents and commotion of the lake into the same positions, subsided in similar order, and formed the plates, which, by repetition, complete a layer. Whenever a deficiency of cement occurred, or some uncohering substance was diffused and subsided upon any portion of the previously formed strata, the subsequent deposit failed to unite with that which preceded, and separation into layers was the consequence.

Of the alternations of sand and clay rock.—In many localities the layers are composed principally of sand, which being heavier than clay, subsided, and separated from the latter, wherever the currents which had borne the materials promiscuously into the lake, became sufficiently diminished. Other extensive, and generally central localities contain layers composed chiefly of clay, which was suspended longer and floated farther into the lake than sand, and coarser materials. A layer of sandstone is sometimes interposed between layers of clay rock. These were, doubtless, products of currents and agitation in the water differing in violence, as we see them now in different years and seasons. With smaller floods and less powerful currents, the suspended sand was deposited nearer to the margin of the common reservoir, but was driven farther into the lake whenever violent currents prevailed, and subsided where beds of clay had been previously deposited, thus producing alternate strata of sand and clay rock.

Of color.—The color of the secondary formation, which is light red, in the coarser sandstone, and dark red or brown, and to a limited extent, deep blue or black in the clay rocks, was doubtless a product of iron ores, diffused in a state of minute division, in the lake. The fine materials of future rock, would both remain longer suspended in contact with the coloring matter, and present more frequent surfaces, to which the latter might adhere. Hence the darker color of the finer rocks.

Cement.—Lime is found crystallized in the seams of many layers, and was probably the chief cementing subtance of the secondary formation. The iron of the coloring matter might contribute to strengthen the cement. Long continued and great pressure, by the weight of water, may also have assisted. Most of the strata in which clay largely predominates, though hard in their natural beds, decompose rapidly and return to clay, when exposed upon the surface of the ground.

Overlying clay.—The formation of secondary rocks seems to have ceased, before the supply and subsidence of materials was discontinued. Over the clay rock in Hartford, Windsor, Suffield and many other places, is a covering, often from ten to twenty feet thick, consisting of uncemented clay, exactly resembling in color and fineness, the substance of decomposed clay rock. These overlying beds of clay preserve no traces of arrangement in plates or layers. They also contain large pebbles and fragments of granite, greenstone, and other rocks, contrary to the invariably fine composition of the clay rock layers beneath. Such beds of clay are penetrated in the excavation of wells in Hartford and other towns, and have been extensively laid open, along the banks of the river at Enfield falls. Besides imbedded pebbles and fragments, the upper strata of the clay rock are found dislocated and mingled with the overlying clay. The broken masses having been lifted and imbedded, were left inclined in all directions, but are capable of being restored to their original position, by bringing together their dislocated joints, which remain as perfect as in layers recently broken.

Lake of the secondary formation.—Was it a fresh-water lake, or a bay from the ocean, which anciently overflowed the bed of the secondary formation? The absence of remains of marine productions indicate the former, and that the lake was little, if at all, open to the influx of tides. It could hardly have been a bay from the same prolific ocean in which were formed the vast beds of limestone and shells that extend from the Hudson river westward.

Outlet of the lake.—If it was a lake, the barrier which upheld its waters must have been since removed; and the outlet was probably in the direction of New Haven. If the present opening in the course of the river, from Middletown to Long Island Sound, had existed, the lake must have flowed into or through it, and it becomes difficult to account for the entire absence of secondary rock, in that direction.

Change of elevation and dip of the secondary.—It has been already remarked that the lake or bay must have been at least coextensive with the secondary formation. It may be added that, unless great changes in the elevation of the sandstone have taken place since it was deposited and formed, the lake must have extended far beyond the limits of the remaining secondary rock. A lake high enough to cover the upper sandstone layers of the Deerfield and Sunderland mountains, would, in the present state of the valley, extend to, and high up the Fifteen mile falls. Its waters would penetrate far into the valleys of the larger tributaries of the Connecticut, and the superficial extent of its surface would be about four times as great as the superficial extent of the secondary formation. Considering how the materials of this formation have been collected from all parts of the Connecticut river valley, it is inconceivable that no sandstone should have been formed in the upper half of the valley, none in the valleys of the tributaries, and none in the present course of Connecticut river below Middletown, if the figure of the superficial rocks has not beeen changed, and the lake in fact was high enough to cover the Deerfield mountains, at their present elevation.

Neither could layers have been formed by deposition or subsidence, in the almost perpendicular position in which some of them repose, in place. Sand or clay, whether above water or under water, falling upon a surface inclined seventy five or eighty degrees to the horizon, could not rest and cohere, preserving the perfect order and uniform arrangement which exist in the plates and layers of those almost perpendicular strata. Rocky strata, so greatly inclined, must, therefore, have undergone a great change of position, subsequently to their formation.

VII. Greenstone Formation.

Extent.—Facts remain to be mentioned which will render it not merely probable, but almost certain, that changes have taken place in the position and elevation of the secondary strata. A variety of rock, different and distinct from both the primitive and the secondary, known under the names of trap, and greenstone, extends with occasional interruptions, from near the north line of Massachusetts to Long Island Sound. Beginning above Greenfield, it forms a hill several miles along the bank of Connecticut river. Again the greenstone rises, in the borders of Belchertown, and forms Mount Holyoke, one thousand feet high,* which running eight miles towards the west, disappears at Rock Ferry, below Northampton. On the opposite side of the Connecticut, the trap rock rises again, in Mount Tom, to the height of a thousand feet, and so continues about six miles towards the south, where it sinks to a hill. The same rocky range

* One thousand feet above the river at this place, and one thousand and one hundred feet above the sea.

extends into West Springfield, Westfield, and Southwick, Ms. and in Connecticut forms the Talcott mountain, Farmington, Meriden, and Southington mountains, and having a number of subordinate parts, and parallel ranges, terminates at East and West rock in New Haven.

Rests upon secondary.—The hills and mountains of trap rock are spread over and rest upon the top of the secondary formation, as may be seen at several places, and at none more distinctly and extensively than at Rocky Hill, three miles south west of Hartford. Similar rocks are found in New Jersey, and other places in the United States, and their usual position, in relation to rocks formed by subsidence in water, is to overlie and rest upon them. That the trap rock hills and mountains were formed, or placed in their present position, after the formation of the secondary strata, is as certain as that the latter were arranged and deposited in water. By what natural agents and modes of action could the trap rocks have been elevated, and placed upon the previously formed beds of sandstone, or clay rock?

Of igneous formation.—It has been extensively maintained by observers of the structure of rocks, that trap, or greenstone, is a product of fusion. Recent observations render it almost certain that some trap ranges have been produced by the melting and hardening of other rocks. The appearance of the trap and sandstone, several feet above and below their junction, is different from the appearance of the same rocks at a greater distance. The color and texture both appear to have been changed, as might be anticipated from the placing of highly heated or melted rock upon strata which were cold. The appearances of both rocks have been described minutely, by Professor Silliman, in the American Journal of Science, for Oct. 1829. He considers the proofs conclusive, that the greenstone of the Connecticut river valley, has hardened into its present state, from a previous state of fusion. To remove all doubt that trap rock has been produced by the fusion of other rocks, it has been observed in volcanic regions, that what is lava at the surface gradually changes below, until the difference between undoubted lava and trap vanishes.

Dykes.—Trap rocks are found in many parts of Europe and America. Besides their more general position, resting upon other rocks, they are found penetrating the earth and solid strata, in veins or dykes, to an unknown depth. Portions of greenstone dykes, disclosed by excavation, have repeatedly been mistaken for artificial walls, and when traced to a considerable extent have excited wonder and astonishment, before the nature of the formation was understood. Such dykes, and others which are doubtless concealed by superincumbent earth and rock, furnish a clew and point to a connection between the mineral stores below, and the trap mountains above the surface of the earth.

Volcanic fires.—That fires of vast intensity and extent, melting rocks and burning them to ashes, exist within the earth, and have existed from ancient times, is universally known. Herculaneum was overwhelmed by the liquid lava of one eruption, and Pompeii buried in the ashes of another. During the last year, a volcanic island was thrown up in the Mediterranean, where ships were wont to sail. In the craters of some volcanoes the lava is raised to a height of several miles.

Earthquakes.—Earthquakes are but different effects of the same subterranean fires which produce volcanic eruptions, and invariably attend them. They rend the earth, swallowing men and their habitations in fearful chasms. They reach from continent to continent, proving the vast extent of subterranean fire and communication. The earthquake which overthrew Lisbon in 1755, extended to New England, and was the severest which has been felt here, since the arrival of Europeans. Probably many of my audience have heard from the people of that day, of the awe produced by the rumbling and quaking of the earth, and the shaking of houses and their contents, here, at a distance of three thousand miles from the seat of the greatest power, and most destructive effects of the earthquake of 1755. Imagination can hardly conceive the extent and fluctuations of melted rock within, when it sees that the craters of Ætna and Vesuvius, of Teneriffe and the Andes, are but vents to relieve occasional excesses of the expanding fires below.

Extinct Volcanoes.—Such being the effects of subterranean fires within the time of authentic records, what must they have been in more ancient periods? Several hundred extinct volcanoes have been discovered by their craters and lava which remain. The extinct volcanic mountains, in the middle and southern parts of France, are said to cover several thousand square miles. The ancient crater of Teneriffe contains a surface of more than one hundred square miles. The whole of the mountainous part of Quito, occupying more than six thousand square miles of surface, is considered, by Humboldt, as one immense volcano.

Effects of subterranean fires.—If such are the number and extent of ancient extinct volcanoes, their subterranean fires must have been proportionally extensive and intense. The earthquakes produced by the same fires were in like degree excessive and violent, causing greater and more frequent fractures and chasms in the rocky crust of the globe. May we not reasonably believe, although no volcanic vent remains open in this region, that the vast fires of ancient times extended under the sandstone formation of the Connecticut river valley? Admit this fact, and the trap mountains here are accounted for. The waves of molten, boiling rock below, might well fracture the brittle covering of sandstone layers above, penetrate the new formed open chasms, rise to the surface, flow over the upper layers of the secondary, by slow degrees acquiring the height and spreading to the breadth of the existing greenstone mountains. The undulations and expanding force of a vast quantity of melted rock below, might elevate mountains, like those of Deerfield, and Sunderland, high above the original surface of the secondary formation to which they belong. The position of the layers would be changed by the heaving of the liquid rock, leaving different portions of the dissevered masses at different degrees of inclination, and dipping in different directions. The operation of these ancient fires may have continued many ages, varying the height of the superficial rocks, and forming fissures, ravines and chasms, to become the channels of future streams and rivers. The present channel of the Connecticut, leaving the secondary basin at Middletown, may have been thus formed or commenced, in a new direction towards the sound. Nor is it incredible that Long Island was anciently united to the continent, and that the concavity which contains the waters of the Sound, was formed by an extensive subsidence of the main land. It is not to be supposed that the internal fires and molten rocks were cooled suddenly: ages might and probably did elapse before all the fractures and the present dip of the superficial strata, and the final elevation of the greenstone mountains were completed.

VIII. Section.

The most undeniable and satisfactory proofs of diverse agencies, and of the order of successive operations, are presented wherever a number of formations are seen in place, lying one above another. Recent excavations in constructing a canal along Enfield Falls, disclosed a series of such formations, which will be described in ascending order. One of the most complete and interesting sections was laid open at the bluff, situated mid-way between the head and foot of the canal.

1. *Sandstone.*—The bed of the river is composed of dark red clay and sandstone rock. Layers of the same rock, dipping commonly ten or twelve degrees towards the northeast or east, form the immediate bank of the river, rising abruptly from ten to thirty feet above the surface of low water, and of unknown depth, probably extending to the primitive strata below. This is part of the extensive and central formation before described, consisting only of materials in a state of minute division, and containing no pebbles or even gravel. The dip to the east indicates that the sandstone strata rise gradually, from the west bank of the river, and the surface of the ground presents a corresponding slope towards the east. Retiring from the river various distances, from a quarter to half a mile, the slope of the surface commonly changes to the west, and after a gradual declination in that direction, and to a considerable distance, the surface again rises with a dip towards the east. Two and even more ranges of similar hills and valleys extend, in places, several miles from the river. In general the superincumbent earth conceals the position of the rocky strata, but where streams break through, it is seen that the western slope is not formed by a change in the dip of the rocky strata, but these are broken off and disappear in successive steps, as if the whole had been originally consolidated in continuous layers, and subsequently cracked, the strata on one side of the fracture being elevated, whilst the other was depressed.

2. *Clay and fragments.*—Next over the red rock lies a bed of red clay and sand, ranging from three or four to twenty feet in thickness. Here, as generally in the red rock below, the predominating material is clay. But the resemblance of the superincumbent clay, in fineness, color, and all apparent qualities, except cement and stratification, to the rock beneath, compels belief that it was collected suspended and deposited in the same lake, and from the same sources as the materials of the rock. In several places thick upper strata of No. 1, are found broken, elevated, and imbedded in the unstratified red clay of No. 2, in entire disorder. In like manner numerous fragments and pebbles of granite and other primitive rocks, and of *water-worn greenstone*, are mingled and often deeply imbedded in the same red clay. The explanation seems to be, that after the purely fine red clay and sand had been deposited above the rocky strata, powerful and unwonted currents swept over the face of the valley, bearing with them vast quantities of fragments and pebbles, from the distant hills and higher water courses. The

same powerful currents, perhaps aided, possibly produced, by fluctuations caused by the renewed energy of subterranean fires, disturbed, softened, and displaced the previously arranged beds of fine red clay, dislocated and intermingled the upper sandstone strata, and rolled and kneaded into the mass various pebbles and fragments, until the whole subsided into their present state of confused mixture. Similar combinations have been noticed in numerous places, over an extent of forty miles, from Hadley falls to Hartford, and below.

3. *Laminated clay-beds.*—As soon as the commotion which produced the mixture of No. 2. had ceased, it is manifest that an extensive surface, consisting chiefly of clay and other fine materials, must have been left exposed to the action of water; if in hills above the surface, to the washing of rains and streams; if below the surface, to the agitations of the lake itself. In this manner, chiefly during periodical, or at least violent storms, successive portions of fine materials would again become suspended and diffused, and finally subside in the manner already described, forming clay-beds, of thin layers often repeated, provided cement were wanting to unite them into rocky strata. Accordingly No. 3 consists of clay-beds, composed of layers, generally about half an inch thick, with sand at bottom, and the finest clay and deepest color at top, and between, a mixture of sand and clay, proceeding upward by insensible gradation from the slightest color, and heaviest materials, to the darkest and finest at top. This arrangement is invariable, in every layer. The greatest elevation of clay-beds along Enfield falls, is about fifty feet above the present surface of the river. They rest upon and terminate in the sides, and never overspread the tops of the higher red clay hills of No. 2. Hence it is probable that during the period of the deposition of No. 3. the waters of the lake, or of the river, if it were then reduced to a river, were not more than fifty feet higher than its present surface; otherwise the layers of clay would have extended farther up the sides of No. 2. The clay-beds which were cut through in forming the canal were of various thickness, containing sometimes twenty, sometimes sixty layers, the latter when the formation commenced at a greater depth than the former. Between Enfield falls and Hartford, the clay-beds rarely attain the height of fifty feet, above low tide. An instrumental level carried twelve miles, from the foot of Enfield falls to Hartford, at a height of thirty feet above low water in the river, touched the margin of nearly thirty brick yards, scattered along the route. Probably the

clay beds at Springfield, and indeed all between Enfield and Hadley falls, belong to the same period of time, and the same elevation of the waters. Unless we suppose that immense quantities of clay belonging to this formation have subsequently been removed, the period of No. 3. was not of long duration. Fifty or sixty years, perhaps less, would suffice to form the greatest number of overlying plates of clay which are known in the region about Enfield falls. The clay beds of different sections of the Connecticut river valley, as they belong to separate lakes, may have been formed at different periods, and remote one from another.

4. *Loose Aggregations.*—Over the surface of the slopes and hills, resting upon the clay beds of No. 3. and where these are wanting, upon the confused mixture of No. 2. lies a disarranged covering, composed of earth, gravel, pebbles, and large and small fragments, embracing fragments of primitive rocks, sandstone, and greenstone. It is perfectly manifest that these materials could not have occupied their present place, during the subsidence of the subjacent layers of clay. It is equally plain that no agencies now operating, either with or without the presence of a lake, could have collected these heavy materials and masses, and spread them over the tops and sides of the hills and slopes where they now lie. A vast amount of sand and gravel is spread over extensive portions of the lower valley, forming barrens or plains remote from the river. These seem to belong to the same period as the coarse covering along Enfield falls above described, (No. 4.) and must be distinguished from the terraces of plains previously mentioned. But one natural agent is adequate and adapted to collect and distribute the materials of No. 4. An overwhelming rush of waters, probably the deluge of the Scriptures, bore along with equal ease the sand, gravel, pebbles, and even larger fragments, which now overspread formations produced in a previous state of tranquillity, filling the deeper cavities where are more remote plains and barrens, and levelling them like the strike of a measure of grain, but leaving a more shallow covering upon the hills whose rocky strata were elevated above the general surface.

5. *Soil.*—A vegetable soil completes the formations, found in place, one above another, at Enfield falls.

SUMMARY.

The principal states and changes which have been described, and of which incontestable proofs remain in the valley of the Connecticut river, are,

1. The disruption of the surface of the primitive rocky strata into fragments, which by disintegration and attrition, produced gravel, sand, clay, and the different kinds and mixtures of earth.

2. A lake or bay extended from the ocean to near the present north line of Massachusetts, in which the secondary strata of the lower valley were formed, by a long continued accumulation, diffusion, and subsidence of materials, collected from all parts of the valley.

3. The lake, and the supply, diffusion and subsidence of gravel, sand, clay, &c. continued as before, but the materials ceased to harden into rock.

4. The dislocation and dip, and the hills, valleys, and mountains, of the secondary strata, were produced, by the agency of subterranean fires.

5. The melted substance of interior rocks rose through chasms and fissures of the previous dislocations, spread over the sand-stone strata, and formed the present ranges of greenstone.

6. Great commotion at and near the surface of the secondary valley, which broke and displaced the upper layers of sandstone, disarranged the superincumbent red clay and sand, introduced among them various kinds of pebbles and fragments, and left an extensive covering of unconsolidated materials, resting upon the secondary rock in a state of confused mixture.

7. A period of tranquillity, in which the clay-beds of the lower valley were formed by deposition in water.

8. Another great commotion at the surface, probably the effects of a deluge, which bore along, and left extensive tracts including the clay-beds of No. 7. covered with unarranged loam, sand, gravel, pebbles and rocky fragments.

9. A chain of lakes subsisting in the central parts of the valley, in which, at uncertain periods, were accumulated and formed the highest terraces of plain. The surface of the lakes subsiding by successive breaches of their barriers, caused the formation of lower plains, and lastly, of the present meadows.

Art. II.—*Memoir of the Life of* Thomas Young, M.D. F.R.S., *Foreign Associate of the Royal Institute of France, &c. &c., with a Catalogue of his Works and Essays.*

(From the Journal of the Royal Institution of Great Britain.)

This tribute to the memory of one of the most gifted men and distinguished philosophers of the age, has been printed solely for private distribution. It has almost the interest of an autobiography, having been drawn up by a gentleman who had the advantage of a long and intimate acquaintance with him, from some short memoranda of Dr. Young's own writing, in the possession of a near connexion. The author modestly states, that 'having never been engaged in the pursuits of accurate science, he feels himself incompetent to give more than an imperfect sketch, which he trusts to see filled up hereafter by an abler hand.'

No apology, it is presumed, will be necessary for transferring to these pages the substance of this account of Dr. Young, who, from his connexion with the Royal Institution, as one of its professors, and as the editor of the first series of its Journal, independent of his claims as a scholar and philosopher of the first class, especially merits distinguished notice in this work.

Thomas Young was born at Milverton, in Somersetshire, on the 13th of June, 1773. His parents were both of them Quakers, and of the strictest of that sect; his mother was a niece of Dr. Richard Brocklesby, a physician of eminence, well known from his connexion with the distinguished literary and political characters of his time, and who numbered among his most intimate friends, Johnson, Burke, and Windham.

To the influence of the early impressions of the Quaker tenets, Dr. Young 'was accustomed to attribute, in some degree, the power he so eminently possessed of an imperturbable resolution to effect any object on which he was engaged, which he brought to bear on everything he undertook, and by which he was enabled to work out his own education almost from infancy, with little comparative assistance or direction from others.' The earliest years of Dr. Young were chiefly passed in the family of his maternal grandfather, Mr. Robert Davis, of Minehead, who, in the midst of mercantile avocations, had cultivated a taste for classical literature, with which, by earnest endeavor, he seems to have imbued the mind of his grandson, who appears to have been a forward if not a precocious child. It is said that he could read with fluency when he was two years old; and soon after this, in the intervals of his attendance on a village schoolmistress, he committed to memory a number of English verses, and even was taught to recite some Latin poems, the words of which he retained without difficulty, although unacquainted with their meaning. Before he was six years old, he was sent to a school kept by a dissenting minister at Bristol, where he remained about a year and a half, and became essentially his own instructor, and had generally studied the last pages of the books used before he had reached the middle under the eye of his inefficient master.

It has been remarked, 'that the early quickness with which learning is imbibed, is not always the indication of permanent ability; facility of acquiring does not in general establish a power of retention; whilst what is received with difficulty, is frequently preserved and digested in the mind.' The case of Dr. Young, however, was one of those happy exceptions to this remark; and in none of those extraordinary instances recorded by Baillet in his work 'sur les Enfans célèbres par leurs Etudes,' is there a more remarkable instance of the promise of youth being realized in the man.

To one of those accidental circumstances, which, though they do not create a peculiar genius, yet very often determine its bent, may be attributed that love of science which distinguished Dr. Young, and which (says his biographer) 'had probably no small influence on the issues of his future life.'—'His father had a neighbor, a man of great ingenuity, by profession a land-surveyor; and in his office, during his holidays, he was indulged with the use of mathematical and philosophical instruments, and the perusal of three volumes of a Dictionary of Arts and Science. These were to him sources of instruction and delight of which he seemed never to be weary.'

In his visits to this neighbor, Young had acquired some knowledge of the art of land-surveying, and used to amuse himself in his walks by measuring heights with a quadrant. In 1782 he was placed at the school of Mr. Thompson, at Compton, in Dorsetshire, where he went through the ordinary course of Greek and Latin, with the elements of mathematics; here also he had access to a moderate miscellaneous library, and by rising earlier and sitting up later than his companions, with the assistance of a school fellow, he acquired some knowledge of the French and Italian languages.

Botany having about this time engaged his attention, and desiring to possess a microscope for the purpose of examining plants, he attempted the construction of one from the descriptions of Benjamin Martin. This led him to optics; and having procured a lathe in order to make his microscope, like most young experimenters, he forgot or neglected science, for a time applied himself to the acquirement of manual dexterity, and every thing gave way to a passion for turning, until, falling upon a demonstration in Martin's Philosophy, which exhibited some fluxional symbols, he was not satisfied until he had read and mastered a short introduction to the doctrine of fluxions.

Before he quitted school, a Hebrew Bible being left in his way, he began by enabling himself to read a few chapters; this led him to the study of the other principal oriental languages; and on quitting Mr. Thompson's, at the age of fourteen, it appears that he was more or less versed in Greek, Latin, French, Italian, Hebrew, Persian, and Arabic; and had laid the foundation of that calligraphic skill for which he was afterwards so remarkable, and in which he rivalled even the neatness and beauty of the pen of Porson.

He was about this time attacked by symptoms of what his friends feared to be incipient consumption, but by the attention of his uncle Dr. Brocklesby, and Baron Dimsdale, his health was restored; his indisposition scarcely interrupted his studious labors, and it is said that 'he merely relieved his attention by what to him stood in the place of repose—a course of Greek reading in such authors as amused the weariness of his confinement.'

In the year 1787, he met, at the house of a relation, a friend of Mr. David Barclay, of Youngsbury, in Hertfordshire, who was then wishing to form an arrangement for the education of his grandson; and it was at length agreed that the youths should pursue their studies together, under a private tutor in Mr. Barclay's house. The tutor, however, did not come, and Young, who was only a year and a half older than his companion, took upon himself provisionally the office of preceptor. They were afterwards joined by Mr. Hodgkin, author of the 'Calligraphia Græca,' who was of somewhat maturer years, and then seeking to perfect himself in the higher branches of classical attainments. But Young did not relinquish the task he had undertaken, and continued to be the principal director of the studies of the whole party.

Thus passed the five years from 1787 to 1792, the summers being spent in Hertfordshire, the winters in London, and with no other assistance than that of a few occasional masters, when in London, he had rendered himself singularly familiar with the great writers of antiquity, keeping ample notes of his daily studies. 'His reading was not,' says his biographer, 'for the purpose of merely gaining words and phrases, and the minuter distinctions of dialects, but was invariably also directed to what was the end and object of the works he labored through;' he had drawn up an admirable analysis of the various conflicting opinions of the ancient philosophers, and it is probable that the train of thought into which this led him was not without its effect in mitigating his attachment to the peculiar views of the Quakers. He had now acquired great facility in writing Latin; composed Greek verses, which were well received by the distinguished scholars of the day, and applied himself assiduously to the higher mathematics. To the studies of botany, zoology, and especially of entomology, he at the same time paid considerable attention.

In the winters of 1790 and 1791, he attended the chemical lectures of Dr. Higgins, and having previously prepared himself by reading on this subject, he began to make simple experiments of his own. But he is said to have been at no period of his life fond of repeating experiments, or even of originating new ones; 'considering that, however necessary to the advancement of science, they demanded a great sacrifice of time, and that when the fact was once established, that time was better employed in considering the purposes to which it might be applied, or the principles which it might tend to elucidate.' At Dr. Brocklesby's recommendation, and under his superintendence, he now directed his views to the studies necessary for the practice of physic, and made to him a regular report of his literary and scientific pursuits. The Doctor lived in intimacy with Mr. Burke and Mr. Windham, and having communicated to them some of his nephew's Greek translations, he was introduced to those two distinguished persons. Mr. Burke is said to have been so greatly struck with the reach of Young's talents, and the extent of his acquirements, and more particularly by his great and accurate knowledge of Greek, that he was in no small degree indebted to the good offices of that eminent statesman for the interest which his uncle afterwards took in his future settlement in life.

'It may probably be considered that it was at this period his character received its developement. He was never known to relax in any object which he had once undertaken. During the whole term of these five years, he never was seen by any one, on any occasion, to be ruffled in temper. Whatever he determined on he did. He had little faith in any peculiar aptitude being implanted by nature for any given pursuits. His favorite maxim was, that whatever one man had done, another might do; that the original difference between human intellects was much less than it was generally supposed to be; that strenuous and persevering attention would accomplish almost any thing; and at this season, in the confidence of youth and consciousness of his own powers, he considered nothing which had been compassed by others beyond his reach to achieve, nor was there any thing which he thought worthy to be attempted which he was not resolved to master.

His biographer thinks, with justice, that 'this self conducted education in privacy was not without its disadvantages—that though the acquirements he was making were great, he was not gaining that which is acquired insensibly in the conflict of equals in the commerce of the world—the facility of communicating knowledge in the form that shall be most immediately comprehended by others, and the tact in putting it forth that shall render its value immediately appreciated.'

His first communications to the press were made in 1791, through the medium of the 'Monthly Review,' and the 'Gentleman's Magazine;' and towards the end of 1792 he established himself in lodgings in Westminster, where he resided two years, attending the lectures of Baillie and Cruickshank on anatomy, and was during that period, a diligent pupil of St. Bartholomew's Hospital.

In 1793, he made a tour in the west of England, principally to study the mineralogy of Cornwall; and about this time the Duke of Richmond, then Master-General of the Ordnance, who had long been a friend of his uncle, offered him the situation of assistant-secretary in his house. Mr. Burke and Mr. Windham recommended him to proceed to Cambridge and study the law, but his own predilections and habits decided him, upon due consideration, to determine in favor of the practice of physic, as most congenial to his scientific pursuits, and to which the position occupied by his uncle seemed to offer a favorable introduction.

In this year he communicated to the Royal Society his Observations on Vision, and his Theory of the Muscularity of the Crystalline Lens of the Eye, which became the object of much discussion: John Hunter laying claim to having previously made the discovery. Dr. Young was soon after elected a fellow of the Royal Society, when he had just completed his twenty-first year; and in the autumn of 1794 he went to Edinburgh, and attended the lectures of Doctors Black, Munro, and Gregory.

He now separated himself from the society of Quakers, and, amidst the most active pursuit of his medical, scientific, and classical labors, still found leisure for cultivating those arts in which his early education had left him deficient. The versatility of his genius reminds us of what has been recorded of the Admirable Crichton. It is said that 'every thing, be its nature what it might, was with him a science; and that whatever he followed, he followed scientifically. Of music he was extremely fond, and of the science of music he rendered himself a master. He had at all times great personal activity, and in youth he delighted in displaying it.'—'He diversified his graver studies by cultivating skill in bodily exercises; took lessons in horsemanship, in which he always had great pleasure; and practised, under various masters, all sorts of feats of personal agility, in which he excelled to an extraordinary degree.' As a characteristic anecdote, it is recorded that, in instructing himself in a minuet, he made it the subject of a diagram.

Toward the close of 1795 he went to the University of Göttingen, where he took his doctor's degree, and excited the wonder of that laborious school by his extraordinary attainments and almost incredible industry. Here he composed a treatise 'De Corporis Humani Viribus Conservatricibus,' leaving few volumes unconsulted which had any connexion with the subject he was treating. He had purposed visiting Italy previously to his return to England, but was prevented by the victories of the French; he therefore proceeded to Dresden, for the purpose of studying the works of Italian art in the galleries there, and of comparing what he saw with that which he had learnt of them from the lectures of the professors at Göttingen. He also made a short visit to Berlin.

'During his residence in Germany he gained a very general and accurate acquaintance with its language and literature, which he kept up throughout his life; he remarked that he found in Germany a love of new inventions, singularly, and somewhat pedantically, combined with the habit of systematizing old ones, and of giving an importance to things in themselves trifling, which in his case rather confirmed an original habit of dwelling on minutiæ more than his subsequent experience led him to think was advantageous.

On his return to England he entered himself of Emmanuel College, Cambridge, of which Dr. Farmer, an intimate friend of his uncle, was then master. He proceeded to take his regular degrees in physic in that university, but did not attend any of the public lectures, contenting himself with pursuing the various studies in which he was engaged, living on terms of intimacy with the most highly-gifted members, and discussing subjects of science with the professors, but finding no rival in the variety of his knowledge, and few competitors in most of its branches.

Dr. Brocklesby died in 1797: part of his fortune, his books, his pictures, and his house, he left to Dr. Young, who now found himself in circumstances of independence, surrounded by a circle of distinguished and highly valuable friends, which he continued to prize and to enjoy through life. When his residence at college was completed he settled himself as a physician in London, in Welbeck Street, where he continued to reside during twenty-five years.

In 1801, Dr. Young was appointed Professor of Natural Philosophy in the Royal Institution, where he continued for two years to lecture alternately with Sir H. Davy. In 1802, he published his 'Syllabus, a course of Lectures on Natural and Experimental Philosophy, with Mathematical Demonstrations of the most important Theorems in Mechanics and Optics.' This syllabus contained the first publication of his discovery of the general law of the Interference of Light, being the application of a principle which has since been universally appreciated as one of the greatest discoveries since the time of Newton, and which has subsequently changed the whole face of optical science.* As a lecturer at the Royal Institution, Dr. Young was not eminently successful, for though his lectures were replete with interesting original matter, he was not happy in conveying it in a sufficiently intelligible manner to the capacities of a mixed audience, consisting in a great degree of persons of fashion and of the world. Dr. Young's style and manner were quite opposite to those of his eminent colleague, Davy; he was compressed and laconic, and presumed his audience better instructed in the arcana of science than such an assembly could possibly be: it has even

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* It was not until the year 1827, that the importance of this law could be said to be fully admitted in England: it was in that year that the Council of the Royal Society adjudged Count Rumford's medal to M. Fresnel, for having applied it, with some modifications, to the intricate phenomena of polarized light.

been said that it would hardly have been possible for men of science to have followed him at the moment without considerable difficulty.

At this period Dr. Young became, jointly with Davy, editor of the Journal of the Royal Institution; the first volume, and part of the second, were published under his superintendence. It was also at this time that he gave his two Bakerian Lectures on the subject of Light and Colors, to the Royal Society. Developing the law of interference, and entering into all the details of the theory to which it leads; dwelling upon the difficult points, at the same time, with more candor than might have been consistent with his object, had he been anxious to obtain proselytes.

'In the summer of 1802, he accompanied the present Duke of Richmond, and his brother Lord G. Lennox, in his medical capacity, to Rouen, and in an excursion from thence to Paris, was first present at the sittings of the National Institute, at that time attended by Napoleon; where he made the acquaintance of several leading members of that distinguished body, into which he himself was eventually elected. On his return, he was constituted Foreign Secretary to the Royal Society, an office which he held during life, being long their senior officer, and always one of the leading and most efficient members of their council.'

In 1804, he married Eliza, daughter of J. P. Maxwell, Esq., of Cavendish Square,—an union to him productive of uninterrupted happiness during the remainder of his life. At this time he resigned his professorship in the Royal Institution, from an erroneous impression that it would be likely to interfere with his success as a medical practitioner. The remarks of his biographer on this occasion must not be withheld.

'His resolution at that juncture was to confine himself for the most part to medical pursuits, and to make himself known to the public in no other character. But he had resolved on that which to him was impossible. He never slackened either in his literary or philosophical researches. He was always aiding, and always willing to be the counsellor of any one engaged in similar investigations. He was living in the first circles of London, amongst all who were the most eminent. The nature of his habitual avocations was necessarily well known; and, therefore in putting forth his non-medical papers separately and anonymously, he was making a fruitless as well as voluntary sacrifice of the general celebrity to which he was entitled; and shrinking, as it were, from the cumulative reputation which he must otherwise have enjoyed, he waived, in some degree, the advantage which is given by a great name towards the pursuit of even professional success.'

In 1807, Dr. Young published his 'Course of Lectures on Natural Philosophy and the Mechanic Arts,' in two volumes, 4to; a work of first-rate merit, which cost him nearly five years' labor to perfect. The mass of references contained in the second volume, to those works which the student engaged in minute inquiries in any branch may consult with advantage, affords evidence of the extensive reading and industry of this eminent philosopher. Owing to the failure of the booksellers engaged in the publication of Dr. Young's Lectures, the immediate sale of the work was so greatly injured that it did not repay the expenses of the publication. Indeed, for some years, its great merits were not so extensively appreciated in England as on the Continent: but at length justice has been done to it in the country which gave it birth,—it is a mine to which every one engaged in scientific pursuits must have recourse with advantage, and it is no less true that 'it contains the original hints of more things since claimed as discoveries, than can perhaps be found in a single production of any known author.' 'One of the men most distinguished for science in Europe has been known to say, that if his library were on fire, and he could save only one book from the conflagration, it should be the Lectures of Dr. Young.'

In 1810, Dr. Young was appointed Physician to St. George's Hospital; but his private practice, though respectable, was never extensive. His biographer has, we think, pointed out the true cause with great discrimination: 'In his profession, his published labors would prove him to have been of the most learned of scientific physicians, and his judgment and acuteness were equally great; but in the practice of medicine he was not one of those who were likely to win the most extended occupation among the multitude. He was averse to some of the ordinary methods by which it is acquired. He never affected an assurance which he did not feel, and had, perhaps, rather a tendency to fear the injurious effects which might eventually result from the application of powerful remedies, than to any overweening confidence in their immediate efficacy. His treatises bear the same impress. That on consumption is a most striking instance of his assiduity in collecting all recorded facts, and his abstinence from drawing inferences from isolated cases, or putting forth that which he did not feel was established with certainty. Possibly he herein was an example, that increase of knowledge does not tend to increase of confidence, and that those whose acquirements are the greatest meet in the progress of their investigations with most that leads to distrust.'

Dr. Young had previously given a course of lectures on the Elements of the Medical sciences at the Middlesex Hospital, of which a syllabus was published in 1809. These lectures, he himself said, were little frequented, 'on account of the usual miscalculation of the lecturer, who gave his audience more information in a given time than it was in their power to follow.'

In 1813, he published his 'Introduction to Medical Literature, including a System of Practical Nosology;' a work of considerable labor and of the highest practical utility. To this work he prefixed a preliminary 'Essay on the Study of Physic,' partly founded on that of the German Professor Vogel, in which is contained his own conception of the qualities requisite to constitute a well educated physician, by which it will appear that his notion of the character was elevated above the ordinary standard of humanity: 'he enumerates nearly every possible quality of which man could wish, but of which few could hope, the attainment.'

Dr. Young was a frequent contributer to the Quarterly Review, having been induced, at the instance of his friend Mr. George Ellis, to furnish articles on medical subjects. His communications, however, soon branched into other lines, connected with the higher departments of science, and containing frequently more of original research than of immediate criticism. In the catalogue of his writings, which accompanies this memoir, will be found a list of his papers in that journal. We shall only here mention an admirable philological dissertation on the Structure of Language, contained in the review of Adelung's Mithridates, Vol. X, October, 1813. This is remarkable, as it was the immediate means of leading him to the investigation of the lost literature of Ancient Egypt. The account of his discoveries on this subject is given in the words of his biographer, because an unjust attempt has been made to wrest from Dr. Young the merit of having first discovered a key to the hieroglyphics.

'In the year 1814, Sir William Rouse Boughton had brought with him from Egypt some fragments of papyri, which he put into the hands of Dr. Young; the fragment of the Rosetta Stone having about this time been deposited in the British Museum, and a correct copy of its three inscriptions having been engraved and circulated by the Society of Antiquaries. Dr. Young first proceeded to examine the Enchorial Inscription, and afterwards the sacred characters; and, after a minute comparison of these documents, he was enabled to attach some "Remarks on Egyptian Papyri, and on the Inscription of Rosetta," *containing an interpretation of the principal parts of both the Egyptian inscriptions on the pillar,* to a paper of Sir William Boughton's, which was published by the Society of Antiquaries in 1815, in the 18th volume of the Archæologia.

'Dr. Young now found that he had discovered a key to the lost literature of Ancient Egypt. He had occupied himself, though without deriving from it the assistance he at first expected, in the study of the Coptic and Thebaic versions of the Scriptures; but having satisfied himself of the nature and origin of the Enchorial character, he produced the result to the world anonymously in the Museum Criticum of Cambridge, part vi, published in 1815; being then determined to prosecute the discovery, but at the same time abstaining from claiming it in a more substantive form, from the resolution he had previously taken to be known only as a medical author.

'The labor he bestowed on these investigations, and the minuteness and accuracy with which he copied the papyri and compared the materials which came into his hands, would be nearly incredible to those who had not access to him whilst employed on this pursuit.

'In 1816, he printed and circulated two additional letters relating to his hieroglyphical discoveries and the inscription of Rosetta; the first addressed to the Archduke John of Austria, who had recently been in this country, the other to M. Akerblad. These letters announce the progress of the discovery of the relation between the Egyptian characters and hieroglyphics, forming the basis on which Dr. Young continued his inquiries, as well as of the system afterwards carried further in its details by M. Champollion, whose attention had long been directed to similar studies, and in which he has since so greatly distinguished himself. The letters were *first published* when reprinted in the seventh number of the Museum Criticum, in 1821; and were, with the former letters in that work, beyond all question or dispute, the earliest announcement of the discovery of a key to a character which had remained uninterpreted for ages.'

The whole results of his discoveries on this subject were first brought out in a perfect and concentrated form in the article Egypt, published in the Supplement to the Encyclopædia Britannica, to which work Dr. Young furnished sixty three articles, scientific, biographical and literary, which are designated by two consecutive letters of the sentence ***Fortunam ex aliis.*** His adoption of this motto is deemed 'to have been caused by the consideration that he had not then succeeded to his wish or expectation in his profession, and that he had reason to complain that the extent and utility of his labors in science, after having been fully appreciated by the philosophers on the Continent, had not appeared to have met with the same acceptance among his own countrymen.'

This feeling was, however, transitory, and was, indeed, hardly well founded. The fact is, that Dr. Young, by those best qualified to form a judgment, was acknowledged to rank in the highest scale, if not to stand at the head, of the men of science and literature of England, and his reputation was duly appreciated on the Continent; but the studious concealment with which his manifold contributions to the stock of human knowledge in science and philology were stolen into the world, prevented him from enjoying that wide extended fame with his countrymen to which he was justly entitled, and which he really did enjoy in an extensive circle of truly eminent friends.

The philosophical articles of Dr. Young in the Supplement to the Encyclopædia Britannica, contain the results of his most elaborate investigations. His biographical sketches in the same work are admirably given; and the Life of Porson, in particular, has been pointed out as 'a masterly production, containing a very interesting indication of some of Dr. Young's opinions, both on the value of classical studies and on the mechanism of the human mind.' The article LANGUAGES, in the same work, contains the fruits of his investigations on the subject, into which he had been led when engaged in reviewing Adelung's Mithridates for the Quarterly Review.

Early in 1817, Dr. Young paid a second visit to Paris, and was received with that consideration due to him in the scientific circles there. He was happy in renewing his intercourse with Humboldt, Arago, Cuvier and Gay-Lussac; and such was the pleasure derived from his flattering reception, that, having occasion to return to London for a short period, he was induced to make a second visit of a few weeks to Paris in the summer of the same year.

In 1818, he was appointed one of the Commissioners for taking into consideration the state of the Weights and Measures employed throughout Great Britain. To this Commission he acted as Secretary, and furnished the scientific calculations and the account of the measures customarily in use, attached to the three reports laid by them before Parliament. It appears to have been Dr. Young's opinion that, 'though theoretically it might be desirable that all weights and measures should be reducible to a common standard of scientific accuracy, yet that practically the least possible disturbance of that to which people had been long habituated was the point to be looked to, and on this ground he was extremely averse to unnecessary changes.'

Towards the end of the same year, Dr. Young was appointed Secretary to the Board of Longitude, with the charge of the supervision of the Nautical Almanack, having been before named one of the Commissioners without his previous knowledge. This appointment was to him a very desirable one, though the labor in which it involved him was great. His anxiety to increase his medical practice henceforth ceased, and it made that the business of his life which had always been congenial to his inclination.

For the first sixteen years after his marriage, Dr. Young had been accustomed to pass his summers at Worthing, with a view to the practice of his profession. He now discontinued his visits, and devoted the summer of 1819 to a hasty tour into Italy. In about five months he visited the most remarkable places, and examined the Egyptian monuments preserved in the museums of that country, returning to England by Switzerland and the Rhine.

From the year 1820 to the close of his life, Dr. Young continued to furnish a variety of astronomical and nautical collections to Mr. Brande's 'Journal of Science,' together with some philological papers.

'In 1821 he published anonymously an "Elementary Illustration of the Celestial Mechanics of La Place, with some additions relating to the motion of Waves and of Sound, and to the Cohesion of Fluids." This volume, and the article "Tides" in the Supplement to the Encyclopædia, Dr. Young considered as containing the most fortunate results of his mathematical labors.' 'He proceeds (says his biographer) in his own course and manner of investigation, and uses his own processes, and the great reach of mind displayed in these works seems universally acknowledged; but whether he has sufficiently established all the points which he considered himself to have proved, remains matter of dispute among those most qualified to judge. They were spoken of in the highest terms of praise by Mr. Davies Gilbert from the chair of the Royal Society; but there are some amongst the most distinguished of surviving English philosophers, who still think that this theory of the Tides rests too exclusively on analogies, and that many of the elements of the computation are too much out of human reach to render the boldness of the original thought susceptible of being subjected to the severity of mathematical deduction.'

'Dr. Young, as a mathematician, was of an elder school, and was possibly somewhat prejudiced against the system now obtaining amongst the continental and English philosophers; as he thought the powers of intellect exercised by a preceding race of mathematicians were in no small danger of being lost or weakened by the substitution of processes in their nature mechanical.'

He again visited Paris in 1823, and in the same year published his 'Account of some Discoveries in Hieroglyphical Literature and Egyptian Antiquities,' in which he gave his own original alphabet, his translations from papyri, and the extensions which his alphabet had received from M. Champollion. This was his first acknowledged non-professional publication since 1804,—having attained his fiftieth year, as he states in his preface, and determined to throw off the shackles by which he had considered himself bound by the etiquette of a medical practitioner.

He made an excursion to Spa and to Holland in 1821, and in this year undertook the medical responsibility and the mathematical direction of a Society for Life Insurance, and declined all participation in the speculation, but had the disinterested satisfaction of witnessing its prosperity. This connexion led him into researches in which he took great interest, and produced his 'Formula for Expressing the Decrement of Human Life,' published in the Philosophical Transactions for 1826; and a 'Practical Application of the Doctrine of Chances,' published in the Journal of Science for October in the same year.

In the previous year he had removed from Welbeck Street to a house which he had built in Park Square, in the Regent's Park, where he led the life of a philosopher, and expressed himself as having now attained all the main objects he had looked forward to in life—of his hopes or his wishes; this end being, to use his own words, 'the pursuit of such fame as he valued, or such acquirements as he might think to deserve it.' In 1827, he was elected one of the eight foreign members of the Royal Institute of France.

With the exception of the consumptive tendency by which his youth had been visited, his health had hitherto been uninterrupted by a day's serious illness. In the summer of 1828, he went to Geneva and appeared to suffer what was to him an unusual degree of fatigue; on great bodily exertion there was a perceptible diminution of strength, and symptoms of age appeared to come upon him, which contrasted strongly with the freedom from complaints he had hitherto enjoyed.

The Commitee of Finance having recommended to the Government the abolition of the Board of Longitude, a bill was passed to that effect, permitting the Admiralty to retain the officer entrusted with the calculations of the Nautical Almanack: this occured during the time that Dr. Young was abroad, but he continued to execute these duties. Whether the measure was well or ill founded we shall not stay to inquire, but it produced great heart-burnings and discontent among those scientific men who considered themselves or their friends treated unhandsomely, as well as illiberally, in the manner in which their services had been dispensed with. It appears that the occasional assistance of men of science was found to be so necessary to many departments connected with the Admiralty, that it was found expedient to form a new council of three members for the performance of duties which had before devolved on the Board of Longitude, and for this purpose Dr. Young, Captain Sabine, and Mr. Faraday, were appointed.

The consequence of this change involved Dr. Young in more labor than his declining state of health rendered him competent to perform without injury, and exacerbated a complaint which must have been long, though insensibly, in progress, but which now was bringing him rapidly to a state of extreme debility. From the month of Febuary 1829, his illness continued with some slight variations, but he was gradually sinking into greater and greater weakness till the morning of the 10th of May, when he expired without a struggle, having hardly completed his fifty sixth year. He was attended through his illness by his friends Dr. Chambers and Dr. Nevinson. The disease proved to be an ossification of the aorta, and every appearance indicated an advance of age, not brought on probably by the natural course of time, nor even by constitutional formation, but by unwearied and incessant labor of the mind from the earliest days of infancy. His remains were deposited in a vault in the church of Farnborough, Kent.

It has been truly said of this extraordinary man, that as a scholar, physician, a linguist, an antiquary, a mathematician, and philosopher, he has added to almost every department of human knowledge that which will be remembered to after times. In the eloquent eulogy pronounced by Mr. Davies Gilbert from the Chair of the Royal Society it is observed, that 'he came into the world with a confidence in his own talents, growing out of an expectation of excellence entertained in common by all his friends, which expectation was more than realized in the progress of his future life. The multiplied objects which he pursued were carried to such an extent, that each might have been supposed to have exclusivly occupied the full powers of his mind ; knowledge in the abstract, the most enlarged generalizations, and the most minute and intricate details, were equally effected by him ; but he had most pleasure in that which appeared to be most difficult of investigation.' 'The example (says Mr. Gilbert) is only to be followed by those of equal perseverance,' the concentration of research within the limits of some defined portion of science, is rather to be recommended than the endeavor to embrace the whole.

Dr. Young's opinion on this subject is stated by his biographer to have been, 'that it was probably most advantageous to mankind that the researches of some inquirers should be concentrated within a given compass, but that others should pass more rapidly through a wider range—that the faculties of the mind were more exercised, and probably rendered stronger, by going beyond the rudiments and overcoming the great elementary difficulties of a variety of studies, than by employing the same number of hours in any one pursuit—that the doctrine of the division of labor, however applicable to material product, was not so to intellect, and that it went to reduce the dignity of man in the scale of rational existence. He thought it impossible to foresee the capabilities of improvement in any science, so much of accident having led to the most important discoveries, that no man could say what might be the comparative advantage of any one study rather than that of another ; and though he would scarcely have recommended the plan of his own as the model of those of others, he still was satisfied in the course which he had pursued.'

It has been said that the powers of the imagination were the only qualities of which Dr. Young's mind was destitute ; the writer of this memoir thinks this want at least doubtful from the highly poetical cast of some of his early Greek translations, and is of opinion that it might with more justice have been said 'that he never cultivated the talent of throwing a brilliancy on objects which he had ascertained did not belong to them,' and that his entire devotion to the simple truth, on all occasions, made him averse to the slightest degree of exaggeration, or even of coloring; and that, whether gifted or not with imagination, Dr. Young would on principle, have abstained from its indulgence.

In all the relations of private life, Dr. Young was as exemplary as his talents were great, and his whole career was one unbending course of usefulness and rectitude.

Art. III.—*An Essay on Chemical Nomenclature, prefixed to the treatise on Chemistry;* by J. J. Berzelius. *Translated from the French,** *with notes, by* A. D. Bache, Prof. of Nat. Philos. and Chem. in the University of Pennsylvania.

The nomenclature explained in this essay, is the language in which are recorded the labors of the most experienced chemist of our day, the author of a work rich in the philosophy as in the details of chemical science. It has also become, to a certain extent, the language of one of the most industrious portions of the chemical community, the chemists of Germany. By the French translation, under the revision of Berzelius, of his Treatise on Chemistry, the system will be placed more immediately before the chemists of France, and will be introduced to the knowledge of many in England and in this country, who may not heretofore have had access to its stores in the original, or in the German translation.

I have thought that by clothing this essay in an English dress and by adding notes explanatory of the views of the author, as developed in his work, some of the difficulties may be removed which must attend the study by those used to a very different nomenclature; and that thus an examination of the system may be induced. If even such a result should not be attained, the study of the work will, it is hoped, be facilitated; a study which cannot fail to afford an adequate reward for any pains which may be taken in its prosecution.

The notes are chiefly illustrative of the text; they attempt to show the views of the author when differing from those to which we

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* The present translation is made, after correcting the errors pointed out by the author, in his list of errata for the first volume of the French translation, which volume he denounced, as being incorrect; the second volume was translated by another person, under the direction of Prof. Berzelius, and to this volume the corrections for the first were appended. With these emendations, it was virtually adopted by the author.

are accustomed, and to give such reasons for them as he has recorded in the pages of his work.

Essay of Berzelius on the Nomenclature of Chemistry.

This article on the nomenclature of Chemistry by which my Elements are prefaced, is addressed to those who have made some progress in the science and are therefore more or less accustomed to a different system. Beginners will become acquainted with the nomenclature as they advance in their course.

Every science requires a systematic nomenclature. That this is especially the case in relation to Chemistry, has been fully proved by the confusion which prevailed before the adoption of the happy idea of De Morveau. The nomenclature which has been in use since 1780 is the fruit of the labors of De Morveau, directed and aided by Lavoisier, Berthollet, and Fourcroy. The great advantage of this system is to be found in the fact, that as soon as we are made acquainted with the composition of a body we can tell its name without having had previously any knowledge of it: thus the memory is not burthened with names. A systematic nomenclature is, moreover, the expression of a theory; so that while theory assigns a name, the name expresses the theory. To this connection of nomenclature and theory the objection has been urged that the nomenclature must undergo changes whenever theories change, which would not be the case if names were arbitrary. Since, however, all changes of theory tend towards greater simplicity, such a change of nomenclature facilitates, instead of retarding the advance of science. In general nothing which tends to render any of the parts of a science stationary can be beneficial to it; all its parts should advance as discovery and information multiply. Changes have been made from time to time, in the nomenclature of Guyton De Morveau, not in accordance with its fundamental principles, and additions have been made to it which do not harmonize with the rest of the system. Authors have adopted names accidentally given to new substances, and as a consequence the nomenclature of Chemistry has by degrees become unwieldy and ill adapted to express many new and even some well known compounds. In order, therefore, to convey my ideas, it was necessary to devise a nomenclature which should be appropriate and at the same time sufficiently analogous to that now used in France, to be easily understood by those accustomed to that system. This nomenclature I shall explain as briefly as possible.

SIMPLE SUBSTANCES.

I. METALLOIDS.(1) (Simple non metallic bodies, all electro-negative.)

Oxygen.	Sulphur.	Bromine.	Carbon.
Hydrogen.	Phosphorus.	Iodine.	Boron.
Nitrogen.	Chlorine.	Fluorine.	Silicium.

II. ELECTRO-NEGATIVE METALS.

Selenium.	Molybdenum.	Tellurium.
Arsenic.	Tungsten.	Titanium.
Chromium.	Antimony.	Tantalum.(2)

III. ELECTRO-POSITIVE METALS.

Gold.	Copper.	Cobalt.	Magnesium.
Platinum.	Uranium.	Iron.	Calcium.
Iridium.	Bismuth.	Manganese.	Strontium.
Osmium.	Tin.	Cerium.	Barium.
Palladium.	Lead.	Zirconium.	Lithium.
Rhodium.	Cadmium.	Yttrium.	Sodium.
Silver.	Zinc.	Glucinium.	Potassium.
Mercury.	Nickel.	Aluminium.	

NOMENCLATURE OF BINARY COMPOUNDS.

The names of the binary combinations are formed by giving to one of the components the termination *ide*, or *uret*, forming the sub-

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(1) Metalloid, a *non*-metallic body. On the subject of this class, Berzelius remarks: "certain simple substances, characterized by peculiar and well marked properties, are called metals; others do not possess these characters. Hence the division into *metallic* and *non-metallic* bodies; the latter class I call by the name of *metalloids*. This division has a connexion with the chemical and electro-chemical relations of bodies, since the metalloids, and their combinations with oxygen, always tend to the positive pole, and consequently are electro-negative. Many of the metals are likewise electro-negative, and if we undertake to draw the line between the two classes, it will be found that the distinctive characters are so gradually lost, that certain bodies may, with as much propriety, be ranked with the one as the other class."

This term, *metalloid*, from its derivation, (*μέταλλον*, a metal, and *εἶδος*, likeness,) would seem to mean a body *like a metal*, and in this sense there was an attempt made to introduce it into chemical nomenclature, to denote the metallic radical of an alkali, &c. The sense in which our author has chosen to employ it is exactly the reverse of this, and should be well fixed in the memory before proceeding. Remarks in relation to the order in which the substances in this table are arranged, will be found in note third.—*Trans.*

(2) Better known to the English and American chemist as Columbium.—*Trans.*

stantive, as *oxide*, *sulphuret*, and to the other component the termination *ous*, or *ic*, forming the adjective, as for example, *sulphurous*, *sulphuric*. The substantive is formed from the electro-negative component, the adjective from the electro-positive. This rule should be strictly observed, that there may be nothing arbitrary in the nomenclature. When the more electro-positive element in a binary combination, belongs to the class of metalloids, or to that of the electro-negative metals, the termination *ide* is generally given to the name derived from the more electro-negative component;(3) but when the more electro-positive element is an electro-positive metal, the termination *uret* is applied to the electro-negative component. Thus, for example, we say, *arsenious sulphide*, *sodic sulphuret*. The termination *ous* given to the more electro-positive element, denotes a combination in a lower proportion than that expressed by *ic*, and qualifies the proportion of the electro-negative element. Proportions lower than either one of these are expressed by prefixing *hypo* to the name of the compound with which the proportions of the element are compared, and higher proportions by prefixing *hyper*. Thus we have *sulphuric acid*, *hyposulphuric acid*, *sulphurous acid*, *hyposulphurous acid*, *hypermolybdic sulphide*. Sometimes the par-

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(3) In the application of this rule to the case of the combination of two electro-negative bodies, we must depend, to a certain extent, upon the author of the system: since it is only *generally* that the termination *ide* is to be given to the more electro-negative body. Examples of deviation from a rigid adherence to this rule are quite frequent.

The substances, in each of the classes which compose the table of simple bodies, being arranged nearly in the order in which the author considers it most convenient to treat them, and not with reference to their electrical relations, a table in which the substances are arranged according to the electro-negative order is subjoined. (See Berzelius, Vol. IV, p. 570.)

Oxygen.	Carbon.	Mercury.	Thorium.
Sulphur.	Antimony.	Silver.	Zirconium.
Nitrogen.	Tellurium.	Copper.	Aluminium.
Fluorine.	Tantalum.	Uranium.	Yttrium.
Chlorine.	Titanium.	Bismuth.	Glucinium.
Bromine.	Silicium.	Tin.	Magnesium.
Iodine.	Hydrogen.	Lead.	Calcium.
Selenium.	——	Cadmium.	Strontium.
Phosphorus.	Gold.	Cobalt.	Barium.
Arsenic.	Osmium.	Nickel.	Lithium.
Chromium.	Iridium.	Iron.	Sodium.
Molybdenum.	Platinum.	Zinc.	Potassium.
Tungsten.	Rhodium.	Manganese.	
Boron.	Palladium.	Cerium.	

Trans.

ticles *sub* or *super*, are prefixed to the name derived from the electro-negative body, as when we say *suboxide*, *superoxide*. We may also use terms of this kind, *sulphuret of copper*, *oxide of iron*, which express the nature of the components of substances, without reference to the proportions in which they are combined.

The electro-negative compounds formed by oxygen have always been distinguished from the electro-positive, formed by the same element in the nomenclature of de Morveau, although no reference was had to such a theoretical distinction. The first class were called *acids*, the second *oxides*. In these names and their terminations, there is a deviation from the rule laid down above, which usage has sanctioned.(4) This marked distinction in nomenclature between the electro-negative and electro-positive compounds is very convenient, and I propose to extend it to all binary compounds.—I shall, therefore, call those combinations of sulphur, selenium, tellurium, chlorine, bromine, iodine, and fluorine, with bodies less electro-negative than themselves, which in their atomic constitution correspond to the acids,(5) by the names *sulphides*, *selenides*, *tellurides*, *chlorides*, *bromides*, *iodides*, and *fluorides:* while those combinations of the same bodies with the electro-positive metals, which in the atomic relations of the components correspond to the bases, I shall term, *sulphurets*, *seleniurets*, *tellurets*, *chlorurets*, *bromurets*, *iodurets*, and *fluorurets*.(6) The same rule should be followed in those combinations

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(4) In a perfect nomenclature, according to the system of Berzelius, the oxides would have the name *oxurets*, and the acids would be called *oxides*. Reference is made in this paragraph to such a consequence of the rule of nomenclature.—*Trans.*

(5) The object of a reference to the atomic relations of the components is developed in the following paragraph, taken from the author's general remarks upon the compounds of the metals with sulphur. (Vol. II, p. 252.) "The combinations of sulphur with the electro-positive metals are called *sulphurets* or *sulphobases*. Those with the electro-negative metals are called *sulphides*, either when their composition is proportional to that of an acid compound of the metal with oxygen, or when they are capable of combining with sulphobases."—*Trans.*

(6) Oxygen, sulphur and tellurium "unite with electro-negative combustibles, forming electro-negative compounds, similar in certain particulars to acids, and with electro-positive combustibles, forming electro-positive compounds, analogous to the bases. These compounds can neutralize each other, just as the oxides neutralize the acids, and thus they produce salts." (Vol. I, p. 220.)

"We have said, in treating of oxygen, that sulphur forms combinations which are analogous to acids, and others analogous to bases. The electro-negative compounds are called *sulphides*, the electro-positive *sulphurets* or *sulphobases*." (Vol. I, p. 253.)

"The combinations of the electro-positive metals with selenium are called *seleniurets* or *seleni-bases*, those of the electro-negative metals are called *selenides*. These latter unite with the former, producing salts." (Vol. II, p. 420.)—*Trans.*

of two electro-negative bodies, which have an atomic constitution corresponding to that of an oxide of the least electro-negative element; for example, we should say *phosphoric chloruret*,(*a*) *carbonic chloruret.*

In the chemical nomenclature used in France, the different degrees of oxidation are denoted by the Greek particles, *proto*, *deuto*, *trito*, prefixed to the name derived from the electro-negative element. The highest degree is frequently expressed by the Latin particle *per.*

I have thought it better to depart from this method, because the resulting names are not manageable in the nomenclature of the more complex combinations. I therefore use the terms, *ferrous oxide*, and *ferric oxide* for *protoxide of iron*, and *deutoxide of iron.* We shall see in the sequel the advantages which result from this nomenclature when applied to the salts in their different degrees of neutralization. Iridium and osmium have more than two oxides which form salts; I prefix to the regular name of the oxide the particle *sus*,(7) and say *susiridious oxide*, *susiridic oxide*, as will be seen in the enumeration of the oxides.

Certain metals have oxides which contain so little oxygen as to be unable to combine with other oxidized bodies. I call these, *suboxides.*(8) Other metallic oxides on the contrary, are too highly oxidized to combine with other oxidized bodies. I call these *superoxides.*(9) The Greek particles, *hypo* and *hyper* should, properly, be used in these cases, since the word *oxide* is of Greek origin, but they are too much alike to be used without confusion.

The nomenclature of oxidized bodies being given, that of the other binary combinations is strictly in accordance with the princi-

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(*a*) The phosphoric chloruret is proportional to an oxide of phosphorus; the carbonic chloruret to the oxide of carbon. That is, the equivalent of oxygen in each case is replaced by an equivalent of chlorine.—*Trans.*

(7) Susoxide. The term in the French translation is susoxide. The derivation I suppose to be from the Latin *sursum*, through the French *sus.* The French particle *sus* is only used as in the following sentences, "quart-en-sus," (one fourth more,) "tiers-en-sus," (one third more.)—*Trans.*

(8) Suboxide. In the French translation *sousoxide.*—*Trans.*

(9) Superoxide. In the French *suroxide.*—*Trans.*

ples of that system. Thus, we say, *phosphorous chloride, phosphoric chloride,*(10) *ferrous chloruret, ferric chloruret.*(11)

COMBINATIONS OF OXYGEN.*(12)

Hydric oxide, (water.)	Protoxide of hydrogen.
Hydric superoxide.	Deutoxide of hydrogen.
Hyposulphurous acid.	
Sulphurous acid.	
Hyposulphuric acid.	
Sulphuric acid.	
Nitrous oxide.(13)	Protoxide of nitrogen.
Nitric oxide.	Deutoxide of nitrogen.
Nitrous acid.	
Nitric acid.	
Hypophosphorous acid.	
Phosphorous acid.	
Phosphoric acid.	

(10) Berzelius admits the existence of three compounds of chlorine with phosphorus, which he calls the *phosphoric chloride, phosphorous chloride* and *phosphoric chloruret.* The first is analogous to phosphoric acid in the proportions of its elements, the second to phosphorous acid, and the third to an oxide of phosphorus. These explanatory remarks are made in accordance with the peculiar views of Berzelius in relation to the composition of the acids of phosphorus.—*Trans.*

(11) Several metals, when finely divided and thrown into chlorine, become heated to redness in the act of combining with the chlorine. These compounds are called *chlorides* when the body united to the chlorine is electro-negative, and *chlorurets* either when the same body is electro-positive, or when, being electro-negative, the proportions in which the bodies combine correspond to an oxide. (Vol. I, pp. 276, 277.)—*Trans.*

* The right hand column contains the names according to the nomenclature in common use, when they differ from those which I use. The synonymes are from the fifth edition of Thenard's Chemistry.—*Berzelius.*

(12) For the synonymes of the original, those to be found in the fourth American edition of Turner's Chemistry have been substituted.—*Trans.*

(13) The composition of the compounds of nitrogen with oxygen is, according to Berzelius—nitrous oxide, two volumes of nitrogen and one of oxygen; nitric oxide, two volumes of nitrogen and two of oxygen. His nitrous acid is the hyponitrous acid of most of the French and English chemists; the nitrous acid of those chemists Berzelius does not regard as a distinct acid, although he admits its composition to be two volumes of nitrogen and four of oxygen, which would place it next below nitric acid. The reason given for this view, is that there is no satisfactory evidence that this nitrous acid combines, either directly or indirectly, with bases, to form salts; the bases, on the contrary, resolve it into nitrous acid (hyponitrous) and nitric acid.—*Trans.*

Chlorous oxide.*(14)	Protoxide of chlorine.
Chlorous acid.	Peroxide of chlorine.
Chloric acid.	
Oxychloric acid.†	Perchloric acid.
Bromic acid.	
Iodic acid.(15)	
Carbonic oxide.	
Carbonic acid.	
Boric acid.	Boracic acid.
Silicic acid.	Silica.
Selenic oxide.	Oxide of selenium.
Selenious acid.	
Selenic acid.	
Arsenious suboxide.(16)	
Arsenious acid.	
Arsenic acid.	

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* It is probable that this gaseous oxide of chlorine is the lowest degree of oxidation of chlorine, I call it *chlorous oxide*, because there probably exists a *chloric oxide*, composed of equal volumes of chlorine and oxygen, not yet discovered.—*Berzelius.*

(14) The views of Berzelius, in relation to the combinations of chlorine and oxygen, differ from those of the French and English chemists, except in relation to the protoxide and chloric acid. He regards the peroxide of chlorine, of Gay-Lussac and Davy, as an acid, (*chlorous acid*,) and alleges that when exposed in its nascent state to bases it combines with them, forming a class of salts. These salts have a peculiar acrid taste, and destroy organic colors. He further contends, that when a base is added directly to chlorous acid, it is not wholly resolved into chloric acid and chlorine, as is proved by adding sulphuric acid, which liberates chlorous acid. The perchloric (oxychloric) acid, Berzelius makes, after applying a correction to the analysis of Stadion, to consist of one volume of chlorine and three of oxygen, but afterwards adopts the later analysis of Mitscherlich, which gives one volume of chlorine to three and a half of oxygen.—*Trans.*

† The use of the name could not be avoided, since the term, *chloric acid*, has been applied to a lower degree of oxidation, and could not be changed without inconvenience.—*Berzelius.*

(15) Iodous acid is rejected, owing to the doubts thrown upon the experiment of Sementini. The number of the Journal of the Royal Institution of Great Britain for August, 1831, contains a reply of Sementini to the criticisms of Wöhler, and a method of preparing iodous acid and the oxide of iodine, by the direct union of iodine and oxygen.—*Trans.*

(16) Arsenious suboxide: the powder obtained by the exposure of metallic arsenic to the air, and which is not usually regarded as a definite compound. In the text this is called arsenic oxide, but the mistake is corrected, in the body of the work, by the use of the term which has been substituted in this translation.—*Trans.*

Chromic oxide.*	Protoxide of chromium.
Suschromic oxide.(17)	
Chromic acid.	
Molybdous oxide.	
Molybdic oxide.	Protoxide of molybdenum.
Molybdic acid.	
Tungstic oxide.	
Tungstic acid.	
Antimonic oxide (Hypantimonious acid.)	Protoxide of antimony.
Antimonious acid.	Deutoxide of antimony.
Antimonic acid.	Peroxide of antimony.
Telluric acid, (Telluric oxide.)	Oxide of tellurium.
Tantalic oxide.	Oxide of tantalum or columbium.
Tantalic acid.	
Titanic oxide.	Protoxide of titanium.
Titanic acid.	Peroxide of titanium.
Aurous oxide.	Protoxide of gold.
Auric oxide.	Peroxide of gold.
Platinous oxide.	Protoxide of platinum.
Platinic oxide.	Peroxide of platinum.
Iridious oxide.(18)	
Susiridious oxide.	
Iridic oxide.	
Susiridic oxide.	
Osmious oxide.(19)	

* Although the green oxide of chromium is the lowest combination now known of chromium with oxygen, I call it *chromic oxide*, because it contains three atoms of oxygen, and is isomorphous with aluminic oxide (alumina), manganic oxide and ferric oxide.—*Berzelius.*

(17) Suschromic oxide. The brown oxide, generally supposed to be a mixture of the oxide and acid of chromium. Berzelius does not admit the experiments of Maus to be conclusive upon this point.—*Trans.*

(18) These four oxides of iridium are obtained by decomposing the corresponding chlorides by an alkali. The quantities of oxygen which they severally contain are in the ratio of 1, 1½, 2 and 3.—*Trans.*

(19) Berzelius considers as proved the existence of four oxides of osmium, and as probable of one intermediate between the third and fourth. The volatile oxide or osmic acid is the only one of these compounds to be obtained, by directly combining osmium with oxygen; the others are obtained from the corresponding chlorides. The proportions of oxygen in the osmious, susosmious and osmic oxides, and in osmic acid, are as 1, 1½, 2 and 4. The proportion of 3 of oxygen, which is wanting, is placed in the table as susosmic oxide; this oxide has a corresponding chloride.—*Trans.*

Susosmious oxide.	
Osmic oxide.	
Susosmic oxide.	
Osmic acid, (Biosmic oxide.)	Oxide of osmium.
Palladious oxide.(20)	Oxide of palladium.
Palladic oxide.	
Argentic oxide.	Oxide of silver.
Argentic superoxide.(21)	
Mercurious oxide.	Protoxide of mercury.
Mercuric oxide.	Peroxide of mercury.
Cuprous oxide.(22)	Protoxide of copper.
Cupric oxide.	Peroxide of copper.
Cupric superoxide.	
Uranious oxide.	Protoxide of uranium.
Uranic oxide.	Peroxide of uranium.
Bismuthic oxide.	Oxide of bismuth.
Stannous oxide.(23)	Protoxide of tin.
Stannic oxide.	Peroxide of tin.
Plumbic suboxide.	
Plumbic oxide.	Protoxide of lead.
Plumbous superoxide.	Deutoxide of lead.
Plumbic superoxide.	Peroxide of lead.
Cadmic oxide.	Oxide of cadmium.
Zincic suboxide.	
Zincic oxide.	Oxide of zinc.
Zincic superoxide.(24)	
Niccolic oxide.	Protoxide of nickel.
Niccolous superoxide.	Peroxide of nickel.
Niccolic superoxide.(25)	

(20) The oxygen in these oxides is as 1 to 2: the first is the well known oxide of palladium.—*Trans.*

(21) Obtained by Ritter, by the aid of galvanism. The oxide of silver, containing less oxygen than the argentic oxide, is not admitted by Berzelius.—*Trans.*

(22) The first two oxides of copper agree with the statement adopted by Turner: the cupric peroxide of Berzelius was obtained by Thenard, by the use of the deutoxide of hydrogen, and was found to contain twice as much oxygen as the cupric oxide.—*Trans.*

(23) Suboxide, gray oxide of tin, obtained by the exposure of tin to the air: its composition is not known.—*Trans.*

(24) Omitted in the original table; obtained by Thenard, by the action of the deutoxide of hydrogen.—*Trans.*

(25) Its existence rendered probable by Thenard; obtained by the action of the deutoxide of hydrogen upon the hydrated oxide.—*Trans.*

Cobaltic oxide.	Protoxide of cobalt.
Cobaltic superoxide.	Peroxide of cobalt.
Cobaltic acid.(26)	
Ferrous oxide.(27)	Protoxide of iron.
Ferric oxide.	Peroxide of iron.
Manganous oxide.(28)	Protoxide of manganese.
Manganic oxide.	Deutoxide of manganese.
Manganic superoxide.	Peroxide of manganese.
Manganic acid.(29)	Manganeseous acid.
Oxymanganic acid.(30)	Manganesic acid.
Cerous oxide.(31)	Protoxide of cerium.
Ceric oxide.	Deutoxide of cerium.
Zirconic oxide, (zirconia.)	Oxide of zirconium.
Thoric oxide, (thorina.)(32)	Oxide of thorinium.
Yttric oxide, (yttria.)	Oxide of yttrium.
Glucinic oxide, (glucina.)	Oxide of glucinium.
Aluminic oxide, (alumina.)	Oxide of aluminium.
Magnesic oxide, (magnesia.)	Oxide of magnesium.
Calcic oxide, (lime.)	Protoxide of calcium.

(26) Cobaltic acid is obtained in combination with ammonia, when that alkali is added to the nitrate of cobalt.—*Trans.*

(27) The black oxide of iron, considered as a combination of the black and red oxides, Berzelius calls *ferroso-ferric oxide.* In thus adopting the Latin termination for the first of the two names, he takes a liberty not sanctioned in his own remarks, as given by the French translator, but in which he is abundantly borne out by analogy. This subject is again referred to, in note 73.

(28) The *red* oxide Berzelius calls *manganoso-manganic oxide.* The names of these oxides are derived from that for manganese, stated by the author to be used by the German chemists, viz. *manganium.* This name prevents confusion between *magnesium* and its compounds, and *manganesium* and its combinations. Its use abbreviates the names of the oxides and of the acids of manganese.—*Trans.*

(29) The manganic acid, obtained by calcining together the peroxide of manganese and the hydrate or nitrate of potassa, forms salts, which, according to Mitscherlich, are isomorphous with the sulphates and chromates. Hence Berzelius infers that it contains three times the quantity of oxygen which exists in manganous oxide.—*Trans.*

(30) Oxymanganic acid remains in solution when a strong acid is added to a dissolved manganate: its salts are isomorphous with the oxychlorates.—*Trans.*

(31) There is a combination of these two oxides, termed by Berzelius *ceroso-ceric oxide.*—*Trans.*

(32) Not in the original table, having been discovered since the publication of the first volume: it is described in Vol. II. This oxide was found by Berzelius, in a mineral from Norway, named *thorite,* which contains 57 per cent. of the earth.—*Trans.*

Calcic superoxide.(33)	Peroxide of calcium.
Strontianic oxide,(34)(strontiana.)	Protoxide of strontium, (strontia.)
Strontianic superoxide.	Peroxide of strontium.
Barytic oxide, (baryta.)	Protoxide of barium.
Barytic superoxide.	Peroxide of barium.
Lithic oxide, (lithina.)(*b*)	Oxide of lithium, (lithia.)
Sodic suboxide.(35)	
Sodic oxide, (soda.)	Protoxide of sodium.
Sodic superoxide.	Peroxide of sodium.
Potassic suboxide.	
Potassic oxide, (potassa.)	Protoxide of potassium.
Potassic superoxide.	Peroxide of potassium.

COMBINATIONS OF NITROGEN.

Ammonia, (trihydric nitruret.) (36)
Ammonium, (tetrahydric nitruret.)
Cyanogen, (carbonic nitruret.) (37)

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(33) Obtained as a hydrate, by dropping lime water slowly into a solution of the deutoxide of hydrogen.—*Trans.*

(34) The French translation has *strontiane*, and as Berzelius preserves the *an* in its combination, it cannot with propriety be rendered *strontia.*—*Trans.*

(*b*) The remarks in note 33 apply also to this case.

(35) The compounds of both sodium and potassium, ranked by Berzelius as suboxides, are supposed by the English chemists to be mixtures of the respective metals with their protoxides.—*Trans.*

(36) To explain the nomenclature of the compounds of nitrogen with hydrogen, we must refer to the peculiar views of Berzelius in relation to the amalgam formed by ammonia, when acted upon by galvanism, in contact with mercury. He supposes that when a solution of ammonia is exposed to galvanic action, in contact with mercury, water is decomposed; the oxygen escapes, while the hydrogen converts the ammonia into a metal, *ammonium*. This metal may, therefore, be represented by ammonia, with an additional volume of hydrogen. When the amalgam is exposed to the action of water, out of the galvanic circuit, the ammonia combines with the water, liberating hydrogen gas. This view Berzelius supports by a reference to the experiment of Gay-Lussac and Thenard, in which the ammoniacal amalgam being admitted into a Torricellian vacuum was resolved into ammonia, hydrogen and mercury: the hydrogen, however, was less in bulk than is required by the theory.

Ammonia, being composed of one volume of nitrogen and three volumes of hydrogen, receives the name of *trihydric nitruret*, while the ammonium, represented by ammonia with an additional volume of hydrogen, is called *tetrahydric nitruret.*—*Trans.*

(37) The English chemists consider cyanogen to be a bicarburet of nitrogen, composed of two volumes of the vapor of carbon and one volume of nitrogen, condensed into one volume. This composition is inferred from the fact that one volume

COMBINATIONS OF SULPHUR.

Phosphorous sulphide.(38)	
Phosphoric sulphide.	
Boric sulphide.	Sulphuret of boron.
Carbonic sulphide.	Bisulphuret of carbon.
Silicic sulphide.	Sulphuret of silicium.
Selenious sulphide.(39)	Sulphuret of selenium.
Subsulphuret of arsenic.(40)	
Hyparsenious sulphide.	Protosulphuret of arsenic, (realgar.)
Arsenious sulphide.	Sesquisulphuret of arsenic, (orpiment.)
Arsenic sulphide.	Persulphuret of arsenic.
Persulphuret of arsenic.	
Chromic sulphuret.	
Suschromic sulphide.	
Molybdous sulphuret.(41)	

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of cyanogen requires for complete combustion two volumes of oxygen, and yields two volumes of carbonic acid and one volume of nitrogen. If one volume of carbonic acid be composed of one volume of vapor of carbon and one volume of oxygen, then one volume of cyanogen must contain two volumes of the vapor of carbon and one volume of nitrogen. Berzelius adopts, for the composition of carbonic acid, one volume of the vapor of carbon and two volumes of oxygen, forming two volumes of carbonic acid: that is, he considers the hypothetical vapor of carbon to be twice as dense as it is made by the English chemists. This view gives in the two volumes of carbonic acid referred to above, as the product of the combustion of one volume of cyanogen, but one volume of the vapor of carbon, and makes cyanogen a compound of equal volumes of the vapor of carbon and of nitrogen, that is, a carburet of nitrogen, (carbonic nitruret.)—*Trans.*

(38) The *sulphides*, it will be recollected, are electro-negative compounds of sulphur, playing the part of acids; that is, combining with the sulphurets or electro-positive compounds, which answer to the bases.—*Trans.*

(39) Obtained by passing sulphuretted hydrogen through *selenious* acid.—*Trans.*

(40) Subsulphuret of arsenic. This compound contains only one twelfth part of the sulphur found in the hyparsenious sulphide, while the persulphuret of arsenic contains nine times as much sulphur as the hyparsenious sulphide. Such a case is not specially provided for in the new nomenclature, hence the names *subsulphuret of arsenic* and *persulphuret of arsenic.*—*Trans.*

(41) Berzelius describes three compounds of sulphur with molybdenum, the first being a base and the two others electro-negative. These latter are the molybdic and hypermolybdic sulphides; the first is the molybdic sulphuret. The proportions of sulphur in these compounds being as 2, 3 and 4, renders probable the existence of a lower compound, the molybdous sulphuret of the table.—*Trans.*

Molybdic sulphuret.	Sulphuret of molybdenum.
Molybdic sulphide.	
Hypermolybdic sulphide.	
Tungstic sulphuret.(42)	Sulphuret of tungsten.
Tungstic sulphide.	
Hypantimonious sulphide, (antimonic sulphuret.)	Protosulphuret of antimony.
Antimonious sulphide.	Sequisulphuret of antimony.
Antimonic sulphide.	Bisulphuret of antimony.
Telluric sulphide.	Sulphuret of tellurium.
Tantalic sulphide.	Sulphuret of columbium.
Titanic sulphide.	Sulphuret of titanium.
Stannous sulphuret.(43)	Protosulphuret of tin.
Susstannous sulphuret.	Sesquisulphuret of tin.
Stannic sulphide.	Bisulphuret of tin.
Aurous sulphuret.(44)	
Auric sulphuret.	Sulphuret of gold.
Platinous sulphuret.	
Platinic sulphuret.	Sulphuret of platinum.

The rest of the series is exactly the same as that of the combinations of oxygen.

There are, however, differences between the series of compounds of sulphur and that of the compounds of oxygen; several metals forming more numerous combinations with sulphur than with oxygen. Potassium, sodium, and ammonium,(45) the radicals of the alkalies

(42) The first of these corresponds to the oxide of tungsten, the second to its acid.—*Trans.*

(43) Although the stannic sulphide alone appears in the table of the original, the three compounds introduced into the translation are to be found in the third volume, under the head of the compounds of tin and sulphur.—*Trans.*

(44) Aurous sulphuret; obtained by passing a stream of sulphuretted hydrogen gas through a solution of the chloride of gold.—*Trans.*

(45) "Ammonium combines with sulphur in several proportions; the compounds may be obtained by distilling the analogous compounds of sulphur and potassium with the ammonic chloride." "In the double decompositions which take place, the potassium combines with the chlorine and the ammonium with the sulphur." "Ammoniacal gas is not absorbed by sulphur, because the hydrogen necessary to produce the metal (ammonium) is wanting. If the vapor of sulphur and ammoniacal gas be passed together through a red hot tube, one part of the alkali is decomposed, yielding its hydrogen to the other part, which is thus converted into ammonium, and nitrogen is liberated. If the products be collected in a receiver, kept at a low temperature, fine yellow crystals of sulphuret of ammonium will be produced. The ratio of the elements to each other, in these crystals, has not been determined."—*Trans.*

each produce four at least, of which one only in each case is a base. Cobalt produces three, only one of which is a base. Iron gives three, two of which are bases. Those sulphurets which are not bases and do not combine with other sulphurets, may without inconvenience be named according to their atomic constitution; for example, *bisulphuret*,(46) *trisulphuret*, *quadrisulphuret*, *persulphuret of potassium*, &c: the last degree contains five atoms of sulphur, which composition it would be difficult to express in the name of the compound. The sulphurets of iron,(47) are—the *ferrous sulphuret*, the *ferric sulphuret*, and the *bisulphuret of iron*: those of cobalt are, the *cobaltic sulphuret*, the *sesquisulphuret*, and the *bisulphuret of cobalt:* those of potassium, sodium, ammonium, &c. are the *potassic*, *sodic*, *ammonic*, *&c. sulphurets*, the *bisulphuret* and *trisulphuret*, *quadrisulphuret*, and *persulphuret of potassium*, *sodium*, *ammonium*, *&c.* By putting the name of the metal in the genitive case when the sulphurets are not bases, they are easily distinguished from those which are.

All that has been laid down in relation to the nomenclature of the compounds of sulphur, applies also to those of selenium and tellurium. Oxygen, sulphur, selenium, and tellurium constitute a distinct class of bodies, which form electro-negative compounds (*acids*, *sulphides*, *selenides*, *tellurides*,) capable of combining with the electro-positive compounds formed by the same bodies, (*oxides*, *sulphurets*, *seleniurets*, *tellurets*,) to produce salts. I shall call this class of simple bodies, *amphigen*(48) bodies. The bases may be distinguished as *oxybases*, *sulphobases*, *selenibases*, *telluribases*.

COMPOUNDS FORMED BY CHLORINE, BROMINE, IODINE, AND FLUORINE.

The four bodies just named possess these common properties. Their combinations with the electro-positive metals are neutral salts

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(46) This supposes the existence of five compounds of sulphur with potassium; the first of these (the potassic sulphuret) is a base; the sulphur in the other four is in the ratio of 2, 3, 4 and 5, respectively. Berzelius admits two other sulphurets, containing sulphur in the proportions of $3\frac{1}{2}$ and $4\frac{1}{2}$, to the quantity contained in the potassic sulphuret.—*Trans.*

(47) Ferrous sulphuret,—protosulphuret of iron. The bisulphuret bears the same name in the English nomenclature. The sulphur in the three sulphurets is in the proportion of 1, $1\frac{1}{2}$ and 2. Besides these Berzelius admits two subsulphurets of iron, containing one eighth and one fourth, respectively, of the quantity of sulphur in the ferrous sulphuret.—*Trans.*

(48) Amphigen; ἀμφω, *both*, and γεννάω, *I generate;* that is, producing compounds corresponding to both *acids* and *bases*.—*Trans.*

and not bases and their compounds with the metalloids rarely combine with these neutral salts. I shall call this group *halogen*(49) bodies (or generators of salts.) The nomenclature of their combinations is analogous to that of the compounds of sulphur. The compound body denominated cyanogen, belongs to this class.

Below are some examples of the nomenclature of the compounds of the halogen bodies with the metalloids, and with the electro-negative metals.

Sulphurous chloruret.	
Sulphuric chloruret.(50)	Chloride of sulphur.
Phosphoric chloruret.	
Phosphorous chloride.(51)	Protochloride of phosphorus.
Phosphoric chloride.	Perchloride of phosphorus.
Bromic chloruret.(52)	
Chloruret of iodine.(53)	
Chloruret of cyanogen.	
Carbonous chloruret.	
Carbonic chloruret.	Protochloride of carbon.
Carbonous chloride.	Perchloride of carbon.
Carbonic oxychloride.	Chlorocarbonic acid gas.
Carbosulphurous oxychloride.(54)	
Boric chloride.	Chloride of boron.
Silicic chloride.	Chloride of silicium.

(49) Halogen; ἅλς, *a salt,* and γεννάω, *I generate.—Trans.*

(50) The composition of the sulphuric chloruret, corresponds to that of hyposulphuric acid; (the composition received before the last examination of the acid by Dr. Thomson;) hence, as Berzelius remarks, the proper name for it would be *hyposulphurous chloride.* He gives preference to the more brief, but, according to his system, inaccurate name of *sulphuric chloruret.*

The sulphurous chloruret is obtained by causing the sulphuric chloruret to take up an additional equivalent of sulphur.—*Trans.*

(51) Phosphorous chloride. When water is decomposed by it, hydrochloric and phosphorous acids are formed; this compound, therefore, is proportional to phosphorous acid. The phosphoric chloride is proportional to phosphoric acid.—*Trans.*

(52) This name is given in the body of the work; the looser appellation, chloruret of bromine, was to be found in the table.—*Trans.*

(53) Chloruret of iodine. When this compound acts upon water, Berzelius states that it forms hydrochloric acid and an unknown oxide of iodine; hence, it is not proportional to either iodous or iodic acids, and its name, chloruret of iodine, is properly given.—*Trans.*

(54) Carbosulphurous oxychloride. A compound of chlorine, oxygen, sulphur and carbon; obtained by the action of moist chlorine gas upon sulphuret of carbon. It consists, according to the proportions in one hundred parts given by Berzelius, of two proportionals of chlorine, two of oxygen, one of sulphur and one of carbon.—*Trans.*

Arsenious chloride.	Protochloride of arsenic.
Arsenic chloride.	Deutochloride of arsenic.
Molybdous chloruret.	
Molybdic chloruret.	
Chromic chloruret.	Chloride of chromium.
Chromic chloride.	
Antimonic chloruret.	Chloride of antimony.
Antimonious chloride.	
Antimonic chloride.	
Tungstic chloruret.	Protochloride of tungsten.
Tungstic chloride.	Perchloride of tungsten.
Telluric chloride.	Chloride of tellurium.
Tantalic chloride.	Chloride of columbium.
Titanic chloride..	Chloride of titanium.
Manganic chloride.	Chloride of manganese.

By substituting the syllables, *brom, iod, fluor* and *cyan* for *chlor,* in the above table, we have the nomenclature of the compounds of *bromine, iodine, fluorine* and *cyanogen* respectively.

COMPOUNDS OF HYDROGEN.

Hydrogen combines with the halogen and amphigen bodies, forming acid compounds, called *hydracids.* The compounds formed with the halogen bodies (*chlorine, bromine,* &c.) are strong acids, resembling the strongest acids which contain oxygen; but the combinations with the amphigen bodies, (*sulphur, selenium,* &c.) are weak acids. For this reason, I have preferred to retain the term *acid,* as applied to the former of the classes just mentioned, the rather, that this term conveys to the mind of a beginner the idea of a compound possessing energetic acid properties.

1st. Hydracids of the Halogen Bodies.(55)

Hydrochloric acid.	(Hydric chloride.)
Hydrobromic acid.	(Hydric bromide.)
Hydriodic acid.	(Hydric iodide.)
Hydrofluoric acid.	(Hydric fluoride.)
Hydrofluoboric acid.	(Hydric and boric fluoride.)
Hydrofluosilicic acid.	(Hydric and silicic fluoride.)
Hydrofluotitantic acid.	(Hydric and titanic fluoride.)
Hydrofluotantalic acid.	(Hydric and tantalic fluoride.)

(55) The terms in both columns of the table below are used by Berzelius.—*Trans.*

Hydrocyanic acid.	(Hydric cyanide.)
Hydrosulphocyanic acid.*	(56)(Hydric sulphocyanide; hydric sulphocyanate.)
Hydrosulphuretted hydrosulpho-cyanic acid.	(Cyanohydric sulphide, bihydric sulphocyanide.†)(57)

2d. Hydracids of the Amphigen Bodies.

Hydric sulphide.	(Sulphuretted hydrogen.)
Carbohydric sulphide.	(Carburet of sulphur combined with sulphuretted hydrogen.)
Cyanous sulphide.‡(58)	

* A combination of cyanic sulphide and hydric sulphide.—*Berzelius.*

(56) Hydrosulphocyanic acid. An acid having sulphocyanogen for its radical. Sulphocyanogen is a compound of one volume of the vapor of sulphur and one volume of cyanogen. Berzelius is disposed to admit the views of Liebeg in relation to the existence of sulphocyanogen, as obtained in a solid form by transmitting chlorine through sulphocyanate of potassa.—*Trans.*

† The same components as in the preceding compounds, but containing twice the quantity of hydric sulphide.—*Berzelius.*

(57) Hydrosulphuretted hydrosulphocyanic acid. "The hydrocyanic acid has the property, in common with sulphuretted hydrogen, of combining with metallic sulphurets, forming salts." "When these combinations are decomposed by an acid, the metal of the sulphuret is oxidized at the expense of the water; thus sulphuretted hydrogen is produced, which, under favorable circumstances, remains in combination with the hydrosulphocyanic acid. Thence results a compound of two hydracids, analogous to the combinations of certain oxacids, as for example the iodic and sulphuric."

Beside these compounds of hydrogen, sulphur and cyanogen, Berzelius describes (Vol. II, p. 223, &c.) hydrohypersulphocyanic acid and hydrosulphuretted cyanogen. When sulphocyanuret of mercury is heated in sulphuretted hydrogen, or in muriatic acid gas, a liquid is obtained which deposits small transparent crystals; these crystals are gradually decomposed, liberating hydrocyanic acid, and leaving an orange matter which Wöhler considers a compound of hydrocyanic acid with twice as much sulphur as is contained in hydrosulphocyanic acid. This is the first compound mentioned above. The second, hydrosulphuretted cyanogen, is obtained when cyanogen and sulphuretted hydrogen are presented to each other over water or alcohol.—*Trans.*

‡ A substance united with sulphobases in the compounds hitherto called sulphocyanides, but which appear to be true sulphocyanites.—*Berzelius.* I have taken the liberty to alter the name in the original, which was *cyanic* sulphide.—*Trans.*

(58) After explaining the theory which makes of sulphocyanogen (cyanous sulphide) a haloid body, like cyanogen, Berzelius observes, (Vol. II, p. 220,) "I should here remark, that the phenomena afforded by sulphocyanogen and its compounds may be differently explained. In fact, the sulphocyanurets may be regarded as sulphosalts in which half the sulphur with the metal constitutes a sulphobase. In this view of the subject, hydrosulphocyanic acid would be composed of hydric sulphide combined with cyanous sulphide; this latter body not having been insulated, as is the case with the boric and silicic fluorides, in their compounds with hydrofluoric

Hydric selenide.	
Hydric telluride.	(Telluretted hydrogen.)

With regard to the combinations of hydrogen with nitrogen, phosphorus and carbon, into which the hydrogen enters in multiple proportions, they may be indicated by numbers as;

Monohydric phosphuret.(59)	
Bihydric phosphuret.	Protophosphuretted hydrogen.
Trihydric phosphuret.	Perphosphuretted hydrogen.
Tetrahydric phosphuret.	
Pentahydric phosphuret.	
Hexahydric phosphuret.	

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acid. But there are circumstances in opposition to this mode of explanation, and which render such an arrangement of the elements improbable. The sulphocyanurets have none of the properties characteristic of the sulphosalts; they resemble rather the haloid salts and oxysalts, combining frequently with the oxide of the metal which they contain, forming subsalts. Further, the hydrosulphocyanic acid may be obtained from the sulphocyanurets of copper, lead, mercury and silver, by the action of hydric sulphide: the metal, in these cases, remains as a sulphobase, which would not be the case if it had previously existed as such in these salts." If the French translator has done the author justice in this latter remark, it does not bear upon the subject as is supposed; for if the sulphocyanurets be regarded as compounds of cyanous sulphide and a sulphuret, the hydric sulphide, when added, combines with the cyanous sulphide, forming hydrosulphocyanic acid, and leaves the metal as a sulphobase.—*Trans.*

(59) In the names of the following compounds of phosphorus and hydrogen, we perceive a deviation from the systematic nomenclature. This is rendered necessary by the multiple increase of the more electro-positive element.

Monohydric phosphuret. This compound is hypothetical. It is more particularly alluded to in the remarks upon the next compound.

Bihydric phosphuret. Davy supposed this gas to contain less phosphorus than the spontaneously inflammable phosphuret. The analysis of Rose makes it more rich in phosphorus than the latter gas. From a strong solution of hypophosphorous acid, he obtained, by heat, a gas varying in composition, but at a mean composed of three volumes of hydrogen and two volumes of the vapor of phosphorus. This gas he *supposes* to be a mixture of two different phosphurets, assumed by Berzelius to be the bihydric and a monohydric phosphuret; whence the latter named compound which heads the list.

Trihydric phosphuret. The spontaneously inflammable compound of hydrogen and phosphorus. The analytical results of Rose are adopted in determining its composition and in giving its name.

Tetrahydric phosphuret. This compound is not formally described, but I infer it to be the "phosphuret of hydrogen," stated to be formed when the trihydric phosphuret is exposed to light. The precise composition is not known, but simply that it contains more hydrogen than the trihydric phosphuret.

Pentahydric phosphuret. Obtained by Rose, by heating the phosphites of lead or tin.

Hexahydric phosphuret. I have not been able to find any account of this compound in Berzelius's work.—*Trans.*

BINARY COMPOUNDS OF THE OTHER METALLOIDS WITH ELECTRO-NEGATIVE METALS.

As the *phosphurets, carburets, borurets, siliciurets, arseniurets,* and *antimoniurets,* rarely combine with each other, their nomenclature may be reduced to a simple expression of the atomic constitution of the compounds. Thus we may say, *carburet, bicarburet, tricarburet of iron; arseniuret, biarseniuret of nickel.*

COMBINATIONS OF THE ELECTRO-POSITIVE METALS WITH EACH OTHER.

These compounds are called *alloys.* They seldom require the application of a specific nomenclature, there being but few known in which the elements are combined in definite proportions. When such occur the termination *uret* is to be given to that part of the name of the alloy, which is derived from the more electro-negative component; as examples we may take *aururet of silver, triaururet of silver, palladiuret of mercury,* &c.

NOMENCLATURE OF THE SALTS.

The changes which we have made in the nomenclature of the bases generally, and especially in the class of oxides, render the formation of a nomenclature for the salts comparatively easy, and permit the expression not only of the elements constituting the salt but of the state of neutralization of the constituents.

I divide the salts into two orders. 1st. *Amphide* salts, composed of a base united to an *acid,* a *sulphide,* a *selenide,* or a *telluride.* They are classed according to the amphigen body which they contain, being divided into *oxysalts, sulphosalts,*(60) *selenisalts,* and *tellurisalts.* Of these four classes, only the first two have been studied.

2nd. *Haloid salts,* composed of a *halogen* body combined with an electro-positive metal; such are the salts of *chlorine, bromine, iodine, fluorine* and *cyanogen.*

A. AMPHIDE SALTS.

In the nomenclature of the amphide salts, a substantive terminating in *ate,* is formed from the name of the acid, sulphide, selenide, or telluride, if the name of the acid, sulphide, &c. terminate in *ic,* or in *ite,* if this latter terminate in *ous.* For example, we say, *sul-*

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(60) Dr. Thomson calls these sulphur salts. (History of Chemistry, Vol. II, p. 316. System of Chem. 7th ed. Vol. II, p. 900.)—*Trans.*

phate, *sulphite*. In order to distinguish the different classes of amphide salts from each other, the name of the amphigen body which a salt contains is prefixed to the name of the salt, as *oxymolybdate*, *sulphomolybdate*, *selenimolybdate*, *tellurimolybdate*. When the nomenclature of the salts was first formed, only one of the classes just alluded to, was known, namely, the *oxysalts;* hence the distinction which has now been made, was not necessary, and the particle *oxy* has never been placed before the names of salts of this class. They have been called simply *sulphates*, *molybdates*, &c. This is a convenient custom to follow, since the oxysalts are the most numerous, and most frequently used. The other amphide salts are readily distinguished from each other and from the oxysalts, by prefixing the name of the amphigen body which they contain.

OXYSALTS.

The different kinds of oxysalts are:

Sulphates.	Oxychlorates.	Selenites.	Tantalates.
Hyposulphates.	Chlorates.	Arseniates.	Titanates.
Sulphites.	Chlorites.	Arsenites,	Manganates.
Hyposulphites.	Bromates.	Chromates.	Cobaltates.
Nitrates.	Iodates.	Molybdates.	Stannates.
Nitrites.	Carbonates.	Tungstates.	Osmiates.
Phosphates.	Borates.	Antimoniates.	Hydrates.(*z*)
Phosphites.	Silicates.	Antimonites.	
Hypophosphites.	Seleniates.	Tellurates.	

The varieties of each kind are the following. The names now in use are placed in the right hand column.

Potassic sulphate.	Sulphate of potassa.
Sodic sulphate.	Sulphate of soda.
Lithic sulphate.	Sulphate of lithia.
Ammonic sulphate.	Sulphate of ammonia.
Barytic sulphate.	Sulphate of baryta.
Strontianic sulphate.	Sulphate of strontia.
Calcic sulphate.	Sulphate of lime.
Magnesic sulphate.	Sulphate of magnesia.
Aluminic sulphate.	Sulphate of alumina.
Glucic sulphate.	Sulphate of glucina.
Yttric sulphate.	Sulphate of yttria.
Zirconic sulphate.	Sulphate of zirconia.

(*z*) An explanation of the peculiar views expressed in this name will be found in the sequel. (See pages 270, 271.)

Cerous sulphate.	Protosulphate of cerium.
Ceric sulphate.	Deutosulphate of cerium.
Manganous sulphate.(*c*)	Protosulphate of manganese.
Manganic sulphate.	
Ferrous sulphate.	Protosulphate of iron.
Ferric sulphate.	Persulphate of iron.
Cobaltic sulphate.	Sulphate of cobalt.
Niccolic sulphate.	Sulphate of nickel.
Zincic sulphate.	Sulphate of zinc.
Cadmic sulphate.	Sulphate of cadmium.
Plumbic sulphate.	Sulphate of lead.
Stannous sulphate.	Protosulphate of tin.
Stannic sulphate.	Persulphate of tin.
Bismuthic sulphate.	Sulphate of bismuth.
Uranious sulphate.	Protosulphate of uranium.
Uranic sulphate.	Persulphate of uranium.
Cuprous sulphate.	Protosulphate of copper.
Cupric sulphate.	Persulphate of copper.
Mercurious sulphate.	Protosulphate of mercury.
Mercuric sulphate.	Persulphate of mercury.
Argentic sulphate.	Sulphate of silver.
Palladious sulphate.	
Palladic sulphate.	
Rhodic sulphate.	Sulphate of rhodium.
Osmious sulphate.	
Susosmious sulphate.	
Osmic sulphate.	
Susosmic sulphate.	
Iridious sulphate.	
Susiridious sulphate.	

(*c*) Berzelius considers that both the protoxide (manganous oxide) and the deutoxide of manganese (manganic oxide) form salts. The salts of the deutoxide are not mentioned by Turner, nor by Thomson in the late edition of his "System of Chemistry." The following account of these salts is given by Berzelius, Vol. IV, p. 168.

"The manganic salts are but little known, owing to the fact that they readily part with oxygen, and are changed into manganous salts, (salts of the protoxide.) Their color is violet passing into red, and sometimes black passing into yellow or red. Combustible bodies, digested in these salts, convert them into manganous salts."

We learn (Vol. IV, p. 178) that the manganic sulphate may be obtained by acting upon the deutoxide of manganese, in fine powder, by *cold* sulphuric acid. This salt cannot bear a boiling heat without decomposition, nor can it be crystallized.

Iridic sulphate.	
Susiridic sulphate.	
Platinous sulphate.	Protosulphate of platinum.
Platinic sulphate.	Persulphate of platinum.
Aurous sulphate.	
Auric sulphate.*	
Tantalic sulphate.	Sulphate of columbium.
Titanic sulphate.	Sulphate of titanium.
Telluric sulphate.	Sulphate of tellurium.
Antimonic sulphate.	Sulphate of antimony.
Hyperantimonious sulphate.	
Hyperantimonic sulphate.	
Hypertungstic sulphate.	Sulphuric and tungstic acids.
Hypermolybdic sulphate.	
Molybdic sulphate.	Deutosulphate of molybdenum.
Molybdous sulphate.	Protosulphate of molybdenum.
Hyperchromic sulphate.	
Chromic sulphate.	Sulphate of chromium.

COMBINATIONS OF WATER.

Before dismissing the subject of the nomenclature of the oxysalts it is proper to say a few words respecting the compounds into which water enters. Water has been considered as playing the part of an acid in its combinations with bases; which have hence been called *hydrates*. Thus we have *potassic hydrate, calcic, ferric, &c. hydrates.* But water combines also with acids, *and in these compounds corresponds to a base.* We should therefore use the terms *hydric sulphate, hydric nitrate, hydric phosphate, &c.* It would be quite as difficult to become habituated to the use of the term *hydric sulphate,* for common *sulphuric acid,* as to that of *hydric oxide* or *hydric acid,* for water. Some chemists call the acids which contain water, *hydrated acids.* Such a denomination is contrary to the principles of nomenclature. I shall call an acid, in which water acts as a base, an *aqueous acid,* and one where there is only a mixture of acid and water a *dilute acid.* As acids more frequently contain water than the reverse, it will be more convenient to express that the acid con-

* These two salts, having the oxides of gold as bases, are not known to exist. I have enumerated them with the others, in order to complete the series of both amphide and haloid salts.—*Berzelius.*

tains no water than that is combined with that liquid. I shall use for such a case the term *anhydrous; anhydrous sulphuric acid* must be understood to mean sulphuric acid containing no water, *aqueous sulphuric acid*, to mean a compound in definite proportions of the acid with water, and *dilute sulphuric acid* any mixture of the acid with water.

SULPHOSALTS.(61)

I shall enumerate only the *classes* of sulphosalts, since the individual salts have a nomenclature corresponding to the similar salts in the series of sulphates, which has just been given.

Sulphohydrates.(62)	Sulphocarbonates.(65)
Sulphocyanates.(63)	Sulphophosphates.
Sulphocyanhydrates.(64)	Sulphophosphites.(66)

(61) "Those combinations of sulphur with the electro-positive metals which correspond in composition to the oxybases (viz. those resulting from the action of the oxybases and sulphuretted hydrogen on each other,) play the parts of bases in the sulphosalts. The combinations containing greater proportions of sulphur do not possess this property, and thus resemble the superoxides: they do not combine with other sulphurets, but may yield their excess of sulphur to metals. Those compounds of sulphur with the electro-negative metals, which correspond to the metallic acids, combine with the electro-positive sulphurets, in such proportions that if the sulphur were replaced by the same number of atoms of oxygen, we should obtain one of the salts formed by the same radicals when combined with oxygen."

"As the electro-positive oxides sometimes combine with each other, so also certain electro-positive sulphurets occasionally unite. Thus the sulphuret of iron unites with the sulphuret of copper. Nature affords us many such combinations, in the mineral kingdom, occurring in a crystallized form. The composition of most of these bodies is such, that by oxidation they become double sulphates." (Vol. III, p. 334, &c.)—*Trans.*

(62) Sulphohydrates, or sulphydrates. Compounds of sulphuretted hydrogen with metallic sulphurets. "Sulphuretted hydrogen converts the alkalies, earths, and other metallic oxides, into sulphurets. Eight of these, namely, those produced by the alkalies and alkaline earths, combine with sulphuretted hydrogen, (hydric sulphide,) forming salts which are soluble in water, &c." The hydrosulphates of potassa, soda, ammonia, &c. of the English and French chemists.—*Trans.*

(63) Sulphocyanates. Compounds of sulphobases with sulphocyanogen, (cyanous sulphide.) See note of Berzelius to cyanous sulphide. This class is not introduced in its place, in the third volume; the view taken, in the second volume, of the compounds of sulphocyanogen, being the reverse of that contained in the note just referred to, viz. that sulphocyanogen is a haloid body. (See note 58.)—*Trans.*

(64) Sulphocyanhydrates. Compounds of sulphobases with hydrosulphocyanic acid. (See note 56.)—*Trans.*

(65) Compounds of sulphobases with the carbonic sulphide.—*Trans.*

(66) The first (sulphophosphates) obtained by digesting a persulphuret, as for example of potassium, with phosphorus, in a closed vessel. The second, (sulphophosphites) by treating in the same way the quadrisulphuret of potassium.—*Trans.*

Sulpharseniates.	Sulphotungstates.
Sulpharsenites.(67)	Sulphantimoniates.
Hyposulpharsenites.	Sulphantimonites.
Sulphochromates.	Hyposulphantimonites.
Hypersulphomolybdates.(68)	Sulphostannates.(69)
Sulphomolybdates.	Sulphotantalates.(*d*)

B. HALOID SALTS.

As the remarks just made in relation to the sulphosalts apply also to this class, I shall, here, give only a few examples, which will show how the series of sulphates may be used to ascertain the name of each species of the haloid salts.

Potassic chloruret.	Chloride of potassium.(*y*)
Sodic chloruret.	Chloride of sodium.
Ammonic chloruret.	Hydrochlorate of ammonia.
Mercurious chloruret.	Protochloride of mercury.
Mercuric chloruret.	Perchloride of mercury.
Sodic ioduret.	Iodide of sodium.
Ferrous ioduret.	Iodide of iron.
Ferric ioduret.	
Potassic ioduret.	Iodide of potassium.
Bioduret of potassium.	
Trioduret of potassium.	
Calcic fluoruret.	Fluoride of calcium.

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(67) Containing, the first a compound of sulphur and arsenic corresponding to arsenic acid; the second a compound proportional to arsenious acid, the arsenic and arsenious sulphides. The hyposulpharsenites (or sulphohyparsenites) contain realgar, (hyparsenious sulphide.)—*Trans.*

(68) The sulphomolybdates contain the molybdic sulphide, (note 41,) and the hypersulphomolybdates the hypermolybdic sulphide; the first mentioned compound is proportional to molybdic acid, the second has no similar compound in the combinations of molybdenum with oxygen.—*Trans.*

(69) Contain the stannic sulphide, which corresponds to the stannic oxide, (peroxide of tin.)

(*d*) Besides the salts enumerated in the table, "there exist *sulphoseleniates*, but only of the more feeble bases." "There are known also, *sulphaurates*, *sulphiridates*, *sulphoplatinates*, *&c.* but in these salts the affinities of the electro-negative sulphuret are very feeble." "It is possible, that, in the dry way, *sulphoborates*, *sulphosilicates*, *sulphotitanates*, and *sulphotantalates* may be formed, which water converts at once into oxysalts, with the disengagement of sulphuretted hydrogen. Experiment has proved this in relation to the sulphotantalates." (Vol. III, p. 372, &c)—*Trans.*

(*y*) The names in this column are those of the common nomenclature.—*Trans.*

Sodic fluoruret.	Fluoride of sodium.
Argentic bromuret.	Bromide of silver.
Magnesic bromuret.	Bromide of magnesium.
Potassic cyanuret.	Cyanide of potassium.
Ammonic cyanuret.	Hydrocyanate of ammonia.
Ferrous cyanuret.	Cyanide of iron.

NOMENCLATURE OF THE ACID AND OF THE BASIC SALTS.

A. AMPHIDE SALTS.

The salts which contain an excess of acid, are generally known as *acid* or *super salts.* By prefixing, to the name of the salt, the particle which expresses the number of proportionals of acid contained in the salt, the relation of acid to base in the neutral salt being called unity, the fact that the salt is acid and the degree of its acidity, are expressed at the same time. For example we say,

Ammoniacal sesquicarbonate.
Sodic bisulphate.
Potassic quadroxalate.

The amphide salts containing an excess of base, are called *basic* or *sub salts. Subphosphate*, *subsulphate* express compounds of phosphoric and of sulphuric acid with a base, in which the latter is in excess. To express the degree of this excess, we use the same particles, which were applied in the cases of the acid salts. The following examples will suffice to show the method of applying these particles.

Sesquicalcic(70) subphosphate.
Bicupric subacetate.
Trialuminic subsulphate.
Quadriplumbic subnitrate.
Sexplumbic subnitrate.

The nomenclature thus shows whether the proportion of base is a multiple by 1½ by 2, 3, 4 or 6, of that required to form a neutral salt.

It is easily seen that the same method applies to the other amphide salts.

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(70) Since the prepositions sesqui, bi, &c. are prefixed to the base in this case and were prefixed to the acid in the acid salts, it seems superfluous to use the term *sub* before the name of the acid; thus *trialuminic sulphate* expresses three proportions of the base to one of the acid, while *sodic bisulphate* would express two proportions of the acid to one of the base.—*Trans.*

B. HALOID SALTS.

1st. *Acid haloid salts.*(71)

An acid haloid salt is composed of a haloid salt, united to the hydracid of its halogen radical; its composition will be sufficiently well expressed by the method exhibited in the following examples.

Acid auric chloruret.	Chloride of gold and muriatic acid.
Acid potassic fluoruret.	Fluoride of potassium and hydrofluoric acid.
Acid ferrous cyanuret.	
Acid ferric cyanuret.	

2nd. *Basic haloid salts.*(72)

The haloid salts combine with oxybases and occasionally with sulphobases. These compounds may be called *oxybasic* and *sulphobasic salts*. When these salts combine with oxybases, we may dispense with expressing the oxygen, and merely call them *basic haloid salts*. Thus far we know of no basic salt, in which, to use an example, the *ferrous chloruret* is combined with the *ferric oxide*, or the *ferric chloruret* with the *ferrous oxide*, consequently the name of the chloruret expresses always the degree of oxidation of the oxybase. But as one atom of a haloid salt may combine with one, two, three or more atoms of a metallic oxide of the same radical, the peculiar composition is expressed as in the following examples:

Basic plumbic chloruret.	Tribasic plumbic chloruret.
Bibasic plumbic chloruret.	Quadribasic plumbic chloruret.

NOMENCLATURE OF THE DOUBLE SALTS, THOSE CONTAINING TWO BASES OR TWO ACIDS.

In proportion as the elements of a compound increase in number, the difficulties of applying the principles of a systematic nomencla-

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(71) The literal translation would be "1st, those with an excess of acid." This conveys an erroneous idea and leads me to suppose that the French translator, has not done the author justice. I have substituted "acid haloid salts." Reference is here made to three divisions of these salts. 1st. *Haloid salts*, those salts formed by a halogen body with a less electro-negative body (chlorides, &c.) 2nd. *Acid haloid salts*, or haloid salts combined with acids. 3d. *Basic haloid salts*, or haloid salts combined with bases. Since these acid haloid salts contain the hydracid of the halogen body which forms the salt, Turner proposes to call them hydro-haloid salts. (See 4th Amer. Ed. p. 450). The name of Berzelius strikes me as most expressive.—*Trans.*

(72) In the French "avec excès de base," but changed for reasons analogous to those given in the note under the head of the acid haloid salts.

Turner proposes for these salts, the term *oxyhaloid salts*, leaving out the basic. Berzelius prefers to leave out *oxy*, and call them basic haloid salts.—*Trans.*

ture are also increased. This difficulty begins to be felt in the *double salts*. In Latin the names of the two bases may be combined so as to make but one word, as for example, *sulphas ammonicoferrosus*, *cyanetum ferrosoammonicum*. This method cannot be applied in translation, without adopting throughout the Latin termination for the first of the two bases; we are therefore obliged to say, *ammonic and ferric sulphate; ferrous and ammonic cyanuret*.(73)

As the composition of these salts varies, several atoms of the one salt combining with a single atom of the other, we may express the relative number of atoms in the name; as, for example, *triferric ammonic sulphate*, *biammonic ferrous cyanuret*. The following are instances of a similar kind:

Trialuminic potassic sulphate.	Alum.
Biplatinic ammonic chloruret.	Muriate of platinum and ammonia.
Triboric potassic fluoruret.	Fluoborate of potassa.
Bisilicic sodic fluoruret.	Fluosilicate of soda.

The same nomenclature may be applied to the double amphide salts having an excess of base, by placing the word *sub* before the name of the acid. Thus we say *cupric biammonic subsulphate*, (cuprum ammoniacum of the Pharmacopœia) *bialuminic*, *trialuminic*, *sexaluminic potassic subsulphate*. We must observe however, that a nomenclature is easily spoiled by attempting to express too much by it, the names being thus rendered either too complex, or disagreeable to the ear.

NOMENCLATURE OF THE SALTS OF AMMONIA.

Before closing this chapter on nomenclature, we must call the attention of the reader to the difference between the meaning of the terms *salt of ammonium*, or *ammonic salt*, and *salt of ammonia* or *ammoniacal salt*. When ammonia forms salts with the acids containing water, an atom of water enters into the composition of the salt which cannot be disengaged, without destroying the salt itself. The hydrogen of this water is in the precise proportion necessary to form ammonium with the ammonia,(74) and the oxygen is the same in

(73) The same considerations which induce the adoption of the Latin termination in the case of those oxides which are combinations of two definite compounds of oxygen with a base, for example, the *ferrosoferric oxide*, seem to me to bear upon this case. Thus we may say *ammonico-ferroso sulphate*, *ferroso-ammonico cyanuret*. The views given in the French, are perhaps those of the translator not of the author.—*Trans.*

(74) On this subject, see note 36.—*Trans.*

quantity as would have been found in any oxybase neutralizing the same quantity of acid. The ammonia and water, therefore, taken together, represent an oxide of the radical *ammonium*, composed of two atoms(75) of the radical and one of oxygen. This mode of representing the compounds of ammonia, *makes them conform to the general analogies of the oxysalts.* In like manner the combination of the *hydric sulphide* with *ammonia* may be considered as the *ammonic sulphuret*, which may combine further, with two, three, four, and five atoms of sulphur. These salts in which ammonia appears to form an oxybase or a sulphobase, I call *ammonic salts or salts of ammonium.*

When on the contrary, ammonia combines with the anhydrous acids, as with carbonic or sulphurous acid gas, or with anhydrous chlorides, fluorides, &c. compounds result which contain *ammonia, but not the oxide of ammonium*, and which have very different properties from the ammonic salts.

They are called, for example, *carbonate of ammonia*, or *ammoniacal carbonate*, *sulphite of ammonia*, &c. Water converts them into salts of ammonium.

Ammonia combines frequently, as such, and not as an oxide of ammonium, with neutral salts. It then produces basic ammoniacal salts. Some examples are subjoined:

Ammoniacal mercuric nitrate.
Ammoniacal argentic sulphate.
Ammoniacal calcic chloruret.
Ammoniacal phosphorous chloride.

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(75) Berzelius considers water as a compound of two atoms of hydrogen and one of oxygen.—*Trans.*

Art. IV.—*On the law of the partial polarization of light by reflexion;* by David Brewster, LL. D. F. R. S. L. & E.

Read before the Royal Society, February 4, 1830.

In the year 1815 I communicated to the Royal Society a series of experiments on the polarization of light by successive reflexions, which contain the germ of the investigations, the results of which I now propose to explain.

From these experiments it appeared that a given pencil of light could be wholly polarized at any angle of incidence, provided it underwent a sufficient number of reflexions, either at angles wholly above or wholly below the maximum polarizing angle, or at angles partly above and partly below that angle; and it was scarcely possible to resist the conclusion, that the light not polarized by the first reflexion had suffered a physical change at each action of the reflecting force which brought it nearer and nearer to the state of complete polarization. This opinion, however, which I have always regarded as demonstrable, appeared in a different light to others. Guided probably by an experimental result, apparently though not really hostile to it, Dr. Young and MM. Biot, Arago, and Fresnel, have adhered to the original opinion of Malus, that the reflected and refracted pencils consist partly of light wholly polarized, and partly of light in its natural state; and more recently Mr. Herschel has given the weight of his opinion to the same view of the subject.

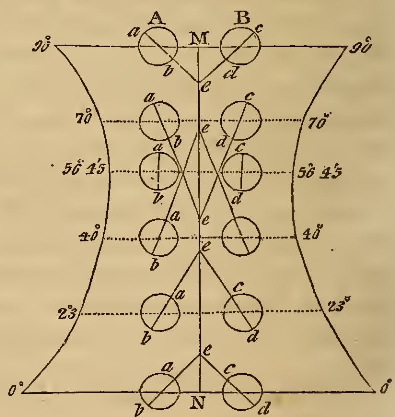
Under these circumstances I have often returned to the investigation with renewed zeal; but though the frequent repetition of my experiments has more and more convinced me of the truth of the conclusions which I drew from them, yet I have not till lately been able to place the subject in a satisfactory aspect, and to connect it with general laws, which give a mathematical form to this fundamental branch of the science of polarization.

If we consider a pencil of natural light as divided into two pencils polarized in rectangular planes by the action of a doubly refracting crystal, and conceive the light of these two pencils to return back through the crystal, it will obviously emerge in the state of natural light. When we examine the pencil thus recomposed, or when we examine a pencil consisting of two oppositely polarized pencils superposed, we shall find that they comport themselves under every analysis exactly like common light; so that we are entitled to assume such a pencil as the representative of natural light, and to consider every thing that can be established respecting the one, as true respecting the other.

In applying this principle to the analysis of the phænomena produced by reflexion, I placed the planes of polarization of the compound beam in the plane of reflexion; but though this led to some interesting conclusions, it did not develope any general law. I then conceived the idea of making the plane of reflexion bisect the right angle formed by the planes of polarization; and in this way I observed a series of symmetrical effects at different angles of incidence, which threw a broad light over the whole subject.

In order to explain these results, let AB (Fig. 1) represent the two pencils of oppositely polarized light as separated by double refraction; let *ab*, *cd* be the directions of their planes of polarization, forming a right angle *a e c*, and let the plane of reflexion MN, of a surface of plate glass, bisect the angle *a e c*, so that the planes *a b*, *c d* form angles of +45° and −45° with the plane MN. Let a rhomb of calcareous spar have its principal section now placed in the plane of reflexion.

Fig. 1.



At an incidence of 90°, reckoned from the perpendicular, the reflected images of A and B suffer no change, the angle *a e c* is still a right angle, and the four pencils formed by the calcareous spar are all of equal intensity. As the incidence however diminishes, the angle *a e c* diminishes also, and the ordinary and extra ordinary images of A and B differ in intensity. At an incidence of 80° for example, the angle *a e c* is reduced from 90° to 66°; at 70° it has been reduced to 40°, and at 56° 45′, the maximum polarizing angle, it has been reduced to 0°; that is, the planes of polarization *a b*, *c d* are now parallel. Below the polarizing angle, at 50°, the axes are again inclined to each other, and form an angle of 22°. At 40° they form an angle of 50°, and at 0°, or a perpendicular incidence, they are again brought back to their primitive inclination of 90°. Taking MN to represent the quadrant of incidence from 90° at M, to 0° at N, the curves, 90°, 0°, show the progressive change which takes place in the planes of polarization, the plane of polarization being a tangent to the curve at the incidence which corresponds to any particular point of it.

When we employ a surface of diamond in place of glass, the inclination of the axes *ab*, *cd* is reduced to 46° at an incidence of 80°, to 8° at an incidence of 70°, and at 67° 43′ the axes become parallel.

Such being the action of the reflecting forces upon A and B taken separately, let us now consider them as superposed and forming natural light. At 90° and 0° of incidence, the reflecting force produces no change in the inclination of their axes or planes of polarization; but at 56° 45′ in the case of glass, and 67° 43′ in the case of diamond, the axes of all the particles are brought into a state of parallelism with the plane of reflexion; and consequently when the image which they form is viewed by the rhomb of calcareous spar, they will all pass into the ordinary image, and thus prove that they are wholly polarized in the plane of reflexion.

All this is entirely conformable to what has been long known: but we now see that the total polarization of the reflected pencil at an angle whose tangent is the index of refraction, is effected by turning round the planes of polarization of one half of the light from right to left, and of the other half from left to right, each through an angle of 45°. Let us now see what takes place at those angles where the pencil is only partially polarized. At 80° for example, the angle of the planes *ab*, *cd* is 66°, that is, each plane of polarization has been turned round in opposite directions from an inclination of 45° to one of 33° with the plane of reflexion. The light has therefore suffered a physical change of a very marked kind, constituting now neither natural nor polarized light. It is not natural light, because its planes of polarization are not rectangular; it is not polarized light, because they are not parallel. It is a pencil of light having the physical character of one half of its rays being polarized at an angle of 66° to the other half. It will now be asked, how a pencil thus characterized can exhibit the properties of a partially polarized pencil, that is, of a pencil part of whose light is polarized in the plane of reflexion, while the rest retains its condition of natural light. This will be understood by replacing the analysing rhomb with its principal section in the plane of reflexion, and viewing through it the images A and B at 80° of incidence. As the axis of A is inclined 33° to MN or the section of the rhomb, the ordinary image of it will be much brighter than the extraordinary image, the intensity of each being in the ratio of $\cos^2 \varphi$ to $\sin^2 \varphi$, φ being the angle of inclination, or 33° in the present case. In like manner the ordinary image of B will be in the same ratio brighter than its extraordinary image, that is, by considering A and B in a state of superposition, the extraordinary image of a pencil of light reflected at 80° will be fainter than the ordinary image in the ratio of $\sin^2 33°$ to $\cos^2 33°$. But this inequality in the intensity of the two pencils is precisely what would be produced by a compound pencil, part of which is polarized in the plane of reflexion, and part of which is common light. When Malus, therefore, and his successors analysed the pencil reflected at 80°, they could not do otherwise than conclude that it was partially polarized, consisting partly of light polarized in the plane of reflexion, and partly of natural light. The action of successive reflexions, however, afforded a more precise means of analysis, in so far as it proved that the portion of what was deemed natural light had in reality suffered a physical change, which approximated it to the state of polarized light; and we now see that the portion of what was called polarized light, was only what may be called apparently polarized; for though it disappears, like polarized light, from the extraordinary image of the analysing prism, yet there is not a single particle of it polarized in the plane of reflexion.

These results must be admitted to possess considerable interest in themselves; but, as we shall proceed to show, they lead to conclusions of general importance. The quantity of light which disappears from the extraordinary image, is obviously the quantity of light which is really or apparently polarized at the given angle of incidence; and if we admit the truth of the law of repartition discovered by Malus, and represented by $P_{oo} = P_o \cos^2 \varphi$, and $P_{oe} = P_o \sin^2 \varphi$, and if we can determine φ for substances of every refractive power, and for all angles of incidence, we may consider as established the mathematical law which determines the intensity of the polarized pencil, whatever be the nature of the body which reflects it,—whatever be the angle at which it is incident,—whatever be the number of reflexions which it suffers, and whether these reflexions are all made from one substance, or partly from one substance and partly from another.

The first step in this investigation is to determine the law according to which a reflecting surface changes the plane of polarization of a polarized ray. This subject was first examined by MALUS, but not with that success which attended most of his labors. Before I was acquainted with what had been done by M. FRESNEL, or with the experiments of M. ARAGO on glass and water, I had made a number of very careful experiments on the same subject, and had represented them by formulæ founded on the law of the tangents. These formulæ, however, I found to be defective; and I am persuaded, from a very extensive series of experiments, that the formulæ of FRESNEL are accurate expressions of the phænomena under every variation of incidence and refractive power. If i is the angle of incidence, i' the angle of refraction, x the primitive inclination of the plane of the polarized ray to the plane of reflexion, and φ the inclination to which that plane is brought by reflexion then, according to FRESNEL, we have

$$\text{Tan}\,\varphi = \tan x \frac{\cos(i+i')}{\cos(i-i')}$$

When x is 45°, as in the preceding observations, then $\tan x = 1$, and we have $\text{Tan}\,\varphi = \frac{\cos(i+i')}{\cos(i-i')}$.

In these formulæ, which are founded on the law of the tangents, $i+i'$ is the supplement of the angle which the reflected ray forms with the refracted ray; while $i-i'$ is the angle which the incident ray forms with the refracted ray, or the deviation produced by refraction.

These formulæ have been verified by M. ARAGO at ten angles of incidence upon Glass, and four upon Water; but his experiments were made only in the case where x is 45°, and where $\tan x$ disappears from the formula. As my experiments embrace a wider range of substances, and also the general case where x varies from 0° to 90°, I consider them as a necessary basis for a law of such extensive application.

The first series of experiments which I made was upon Plate Glass, in which the maximum polarizing angle was nearly 56°: hence I assume the index of refraction to be 1.4826. The following were the results:

PLATE GLASS.

Angle of Incidence.	Angle of Refraction.	Inclination of Plane of Polarization to Plane of Reflexion. Observed.	Computed.	Difference.
90°	0° 0′	45° 0′	45° 0′	0° 0′
88	42 23	43 4	42 49	+0 35
86	42 17	40 43	40 36	+0 7
84	42 8	38 47	38 22	+0 25
80	41 37	33 13	33 46	−0 33
75	40 40	28 45	27 41	+1 4
70	39 20	22 6	21 3	+1 3
65	37 41	14 40	13 53	+0 47
60	35 45	6 10	6 16	−0 6
56	34 0	0 0	0 0	0 0
50	31 22	9 0	9 0	0 0
45	28 29	16 55	16 31	+0 24
40	25 42	22 37	23 1	−0 24
30	19 43	32 25	33 19	−0 54
20	13 20	39 0	40 4	−1 4
10	6 44	44 0	43 49	+0 11

These results, obtained in every part of the quadrant, completely establish the accuracy of the formula. The differences are all within the limits of the errors of observation, and amount, at an average, to 32½′ on each observation.

It is a curious circumstance, which I believe has not before been remarked, that at an incidence of 45° the deviation produced by refraction, or $i - i'$, is, in every substance, the complement of the angle of refraction i to 45°; and in the action of all substances upon polarized light at an incidence of 45°, the rotation of the plane of polarization of a pencil polarized + 45°, or − 45°, is equal to the the angle of refraction; while the inclination of the plane of polarization to the plane of reflexion, or φ, is equal to the deviation $i - i'$.

In order to establish the accuracy of the formula for different degrees of refractive power, I made the following experiments on Diamond, in which the index of refraction was 2.440.

DIAMOND.

Angle of Incidence.	Angle of Refraction.	Inclination of Plane of Polarization to Plane of Reflexion. Observed.	Calculated.	Difference.
90° 0′	24° 12′	45° 0′	45° 0′	0° 0′
85 0	24 6	34 30	33 56	+0 34
80 0	23 48	24 0	23 12	+0 48
75 0	23 19	14 30	13 8	+1 22
70 0	22 39	4 30	3 54	+0 36
67 43	22 17	0 0	0 0	0 0
60 0	20 47	12 30	11 41	+0 49
50 0	18 18	24 0	23 30	+0 30

These differences, which at an average amount to 46½′, are also within the limits of the errors of observation.

In all these experiments the value of x was 45°; but in order to determine the law of variation for φ, when x varies from 0° to 90°, I took a crystal of quartz with a fine natural surface parallel to its axis; and I found that at an angle of incidence of 75°, and when x was 45°, the inclination of the plane of polarization to the plane of reflexion was 26° 20′. I then varied x, and obtained the following results:

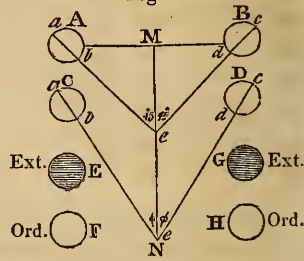
Values of x.	Inclination of Plane of Polarization. φ Observed.	φ Calculated.	Difference.
0°	0° 0′	0° 0′	0° 0′
10	4 54	4 29	+0 25
20	10 0	10 16	−0 16
30	15 50	16 2	−0 12
35	20 0	19 12	+0 48
40	23 30	22 40	+0 50
45	26 20	26 27	−0 7
50	30 0	30 40	−0 40
55	35 30	35 23	+0 7
60	40 0	40 45	−0 45
70	53 0	53 49	−0 49
80	70 0	70 29	−0 29
90	90 0	90 0	0 0

In these experiments the average error does not exceed half a degree. The third column is computed by the formula $\tan \varphi = (\tan 26° 27') \tan x$.

From these experiments it appears that the formula expresses with great accuracy all the changes in the planes of polarization which are produced by a single reflexion, and we may therefore apply it in our future investigations.

Let us now suppose that a beam of common light, composed of two portions A, B, (Fig. 2,) polarized $+45°$ and $-45°$ to the plane of reflexion, is incident on a plate of glass at such an angle that the reflected pencil composed of C and D has its planes of polarization inclined at an angle φ to the plane MN. When a rhomb of calcareous spar has its principal section in the plane MN, it will divide the image C into an extraordinary pencil E and an ordinary one F; and the same will take place with D, G being its extraordinary and H its ordinary image. If we represent the whole of the reflected pencil or C+D by 1, then $C=\frac{1}{2}$, $D=\frac{1}{2}$, $E+F=1$, and $G+H=1$. But since the planes of polarization of C and D are each inclined φ degrees to the principal section of the rhomb, the intensity of the light of the doubly refracted pencils will be as $\sin^2\varphi : \cos^2\varphi$; that is, the intensity of E will be $\frac{1}{2}\sin^2\varphi$, and that of F, $\frac{1}{2}\cos^2\varphi$. Hence it follows that the difference of these pencils, or $\frac{1}{2}\sin^2\varphi - \frac{1}{2}\cos^2\varphi$, will express the quantity of light which has passed from the extraordinary image E into the ordinary one F, that is, the quantity of light apparently polarized in the plane of reflexion MN. But as the same is true of the pencil D, we have $2(\frac{1}{2}\sin^2\varphi - \frac{1}{2}\cos^2\varphi)$ or $\sin^2\varphi - \cos^2\varphi$ for the whole of the polarized light in a pencil of common light C+D. Hence, since $\sin^2\varphi + \cos^2\varphi = 1$ and $\cos^2\varphi = 1 - \sin^2\varphi$, we have for the whole quantity of polarized light

Fig. 2.



$$Q = 1 - 2\sin^2\varphi.$$

But $$\text{Tan}\,\varphi = \tan x \frac{\cos(i+i')}{\cos(i-i')}$$

And as $$\text{Tan}^2\varphi = \frac{\sin^2\varphi}{\cos^2\varphi}, \text{ and } \sin^2\varphi + \cos^2\varphi = 1,$$

we have the quotient and the sum of the quantities $\sin^2\varphi$ and $\cos^2\varphi$, by which we obtain

$$\text{Sin}^2\varphi = \frac{1}{\dfrac{1}{\left(\tan x \dfrac{\cos(i+i')}{\cos(i-i')}\right)^2} + 1} = \frac{\left(\tan x \dfrac{\cos(i+i')}{\cos(i-i')}\right)^2}{1 + \left(\tan x \dfrac{\cos(i+i')}{\cos(i-i')}\right)^2}$$

That is, $$Q=1-2\frac{\left(\tan x\frac{\cos(i+i')}{\cos(i-i')}\right)^2}{1+\left(\tan x\frac{\cos(i+i')}{\cos(i-i')}\right)^2}$$

As the quantity of reflected light is here supposed to be 1, we may obtain an expression of Q in terms of the incident light by adopting the formula of FRESNEL for the intensity of a reflected ray. Thus

$$Q=\tfrac{1}{2}\left(\frac{\sin^2(i-i')}{\sin^2(i+i')}+\frac{\tan^2(i-i')}{\tan^2(i+i')}\right)\left(1-2\frac{\left(\frac{\cos(i+i')}{\cos(i-i')}\right)^2}{1+\left(\frac{\cos(i+i')}{\cos(i-i')}\right)^2}\right)$$

As $\tan x=1$ in common light, it is omitted in the preceding formula.

This formula may be adapted to partially polarized rays, that is, to light reflected at any angle different from the angle of maximum polarization, provided we can obtain an expression for the quantity of reflected light.

M. FRESNEL's general formula has been adapted to this species of rays, by considering them as consisting of a quantity a of light completely polarized in a plane making the angle x with that of incidence, and of another quantity $1-a$ in the state of natural light. Upon this principle it becomes

$$I=\frac{\sin^2(i-i')}{\sin^2(i+i')}\cdot\frac{1+a\cos^2 x}{2}+\frac{\tan^2(i-i')}{\tan^2(i+i')}\cdot\frac{1-a\cos^2 x}{2}.$$

But as we have proved that partially polarized rays are rays whose planes of polarization form an angle of $2x$ with one another, as already explained, x being greater or less than 45°, we obtain a simpler expression for the intensity of the reflected pencil, viz. the very same as that for polarized light.

$$I=\frac{\sin^2(i-i')}{\sin^2(i+i')}\cos^2 x+\frac{\tan^2(i-i')}{\tan^2(i+i')}\sin^2 x.$$

Hence we have

$$Q=\left(\frac{\sin^2(i-i')}{\sin^2(i+i')}\cos^2 x+\frac{\tan^2(i-i')}{\tan^2(i+i')}\sin^2 x\right)$$
$$\times\left(1-2\frac{\left(\tan x\frac{\cos(i+i')}{\cos(i-i')}\right)^2}{1+\left(\tan x\frac{\cos(i+i')}{\cos(i-i')}\right)^2}\right)$$

This formula is equally applicable to a single pencil of polarized light of the same intensity as the pencil of partially polarized light. In all these cases it expresses the quantity of light really or apparently polarized in the plane of reflexion.

In order to show the quantity of light polarized at different angles of incidence, I have computed the following table for common light, and suited to glass in which $m = 1.525$.

PLATE GLASS.

Angle of Incidence i.		Angle of Refraction i'.		Inclination of Plane of Polarization to Plane of Reflexion. ϕ.		Quantity of Light reflected out of 1000 Rays.	Quantity of Polarized Light Q.	Ratio of Polarized to Reflected Light.
°	′	°	′	°	′			
0	0	0	0	45	0	43.23	0	0
10	0	6	32	43	51	43.39	1.74	0.04000
20	0	12	58	40	13	43.41	7.22	0.16618
25	0	16	5	37	21	43.64	11.6	0.26388
30	0	19	8½	33	40	44.78	17.25	0.3853
35	0	22	6	29	8	46.33	24.37	0.5260
40	0	24	56	23	41	49.10	33.25	0.6773
45	0	27	37½	17	22½	53.66	44.09	0.82167
50	0	30	9	10	18	61.36	57.36	0.9360
56	45	33	15	0	0	79.5	79.5	1.000
60	0	34	36	5	4½	93.31	91.6	0.9628
65	0	36	28	12	45	124.86	112.7	0.90258
70	0	38	2	18	32	162.67	129.80	0.79794
75	0	39	18	26	52	257.26	152.34	0.59154
78	0	39	54	30	44	329.95	157.67	0.47786
79	0	40	4	31	59	359.27	157.69	0.43892
80	0	40	13	33	13	391.7	156.6	0.40000
82	44	40	35	36	22	499.44	145.4	0.29112
84	0	40	42	38	2	560.32	134.93	0.2408
85	0	40	47	39	12	616.28	123.75	0.2008
86	0	40	51	40	22.7	676.26	108.67	0.16068
87	0	40	54	41	32	744.11	89.83	0.12072
88	0	40	57½	42	42	819.9	65.9	0.0804
89	0	40	58	43	51	904.81	36.32	0.04014
90	0	40	58	45	0	1000.0	0	0.0000

As the preceding formula is deduced from principles which have been either established by experiment or confirmed by it, it may be expected to harmonize with the results of observation. At all the limits where the pencil is either wholly polarized or not polarized at all, it of course corresponds with experiment: but though in so far as I know there have been no absolute measures taken of the quantity of polarized light at different incidences, yet we are fortunately in possession of a set of experiments by M. Arago, who has ascertained the angles above and below the polarizing angle at which glass and water polarize the same proportion of light. In no case has he measured the absolute quantity of the polarized rays; but the comparison of the values of Q at those angles at which he found them in equal proportions, will afford a test of the accuracy of the formula. This comparison is shown in the following table, in which col. 1. contains the angles at which the reflecting surface polarizes equal proportions of light; col. 2. the values of φ or the inclination of the planes of polarization; and col. 3. the intensities of the polarized light computed from the formula.

	Angles of Incidence i.	Inclination of Planes of Polarization to M N, or φ.	Proportion of Polarized light or Q.
Glass: No. 1.	82° 48′	37° 33′	.2572
	24 18	37° 21	.2637
No. 2.	82 5	36 47	.2828
	26 6	36 0	.3090
No. 3.	78 20	32 38	.4186
	29 42	33 1	.4064
Water: No. 4.	86 31	41 54	.1080
	16 12	41 27	.1236

The agreement of the formula with experiments made with as great accuracy as the subject will admit must be allowed to be very satisfactory. The differences are within the limits of the errors of observation, as appears from the following table:

	Deviations from Experiment.	Part of whole Light.
Glass: No. 1.	0.0065	$\frac{1}{154}$
No. 2.	0.0262	$\frac{1}{38}$
No. 3.	0.0122	$\frac{1}{82}$
Water: No. 4.	0.0156	$\frac{1}{64}$

M. Arago has concluded, from the experiments above stated, that equal proportions of light are polarized at equal angular distances from the angle of complete polarization. Thus in Glass No. 1. the mean of 82° 48′ and 24° 18′ is 53° 33′, which does not differ widely from the maximum polarizing angle, or 55°, which M. Arago considers as the maximum polarizing angle of the glass *. In order to compare this principle with the formula, I found that in Water No. 4. the angle which polarizes almost exactly the same proportion of light as the angle of 86° 31′, is 15° 10′, the value of φ being 41° 54′ at both these angles; but the mean of these is 50° 50′ in place of 53° 11′; so that the rule of M. Arago cannot be regarded as correct, and cannot therefore be employed, as he proposes, to determine the angle of complete polarization†.

The application of the law of intensity to the phænomena of the polarization of light by successive reflexions, forms a most interesting subject of research. No person, so far as I know, has made a single experiment upon this point, and those which I have recorded in the Philosophical Transactions for 1815, have, I believe, never been repeated. All my fellow laborers, indeed, have overlooked them as insignificant, and have even pronounced the results which flow from them to be chimerical and unfounded. Those immutable truths, however, which rest on experiment, must ultimately have their triumph; and it is with no slight satisfaction, that, after fifteen years of unremitted labor, I am enabled not only to demonstrate the correctness of my former experiments, but to present them as the necessary and calculable results of a general law.

When a pencil of common light has been reflected from a transparent surface, at an angle of 61° 3′ for example, it has experienced such a physical change, that its planes of polarization form an angle of 6° 45′ each with the plane of reflexion. When it is incident on another similar surface at the same angle, it is no longer common light in which $x = 45°$, but it is partially polarized light in which $x = 6° 45′$. In computing therefore the effect of the second reflexion, we must take the general formula $\tan\varphi = \tan x \left(\frac{\cos(i+i')}{\cos(i-i')}\right)$; but, as the value of x is always in the same ratio to the value of φ, however great be the number of reflexions, we have $\tan\theta = \tan^n\varphi$ for the inclination θ to the plane of reflexion produced by any number of reflexions n, φ being the inclination for one reflexion. Hence when θ is given by observation, we have $\tan\varphi = \sqrt[n]{\theta}$. The formula

* Hence we have assumed $m = 1.428$, the tangent of 55°, in the preceding calculations.

† It is obvious that the rule can only be true when $m = 1.000$; so that its error increases with the refractive power.

for any number n of reflexions is therefore $\tan\theta = \left(\frac{\cos(i+i')}{\cos(i-i')}\right)^n$.
It is evident that θ never can become equal to 0°; that is, that the pencil cannot be so completely polarized by any number of reflexions at angles different from the polarizing angle, as it is by a single reflexion at the polarizing angle; but we shall see that the polarization is sensibly complete in consequence of the near approximation of θ to 0°.

I found, for example, that light was polarized by two reflexions from glass at an angle of 61° 3′, and 60° 28′ by another observation. Now in these cases we have

	θ after 1st Reflexion.	θ after 2nd Reflexion.	Quantity of Unpolarized light.
Two reflexions at 61° 3′	6° 45′	0° 47′	0.00037
60 28	5 38	0 33	0.00018

The quantity of unpolarized light is here so small as to be quite inappreciable with ordinary lights.

In like manner I found that light was completely polarised by five reflexions at 70°. Hence by the formula we have

	Values of θ.	Unpolarized Light.
1 reflexion at 70°	20° 0′	0.23392
2	7 32	0.03432
3	2 45	0.00460
4	1 0	0.00060
5	0 22	0.00008

The quantity of unpolarized light is here also unappreciable after the fifth reflexion.

In another experiment I found that light was wholly polarized by the separating surface of glass and water at the following angles:

		Values of θ.	Unpolarized Light.
By 2 reflexions at	44° 51′	0° 56′	0.0005
By 3	42 27	0 26	0.0001

In all these cases the successive reflexions were made at the same angle; but the formula is equally applicable to reflexions at different angles,—

1. When both the angles are greater than the polarizing angle.

	θ	Unpolarized Light.
1 reflexion at 58° 2′, and 1 at 67° 2′	0° 34′	0.0002

2. When one of the angles is above and the other below the polarizing angle.

	θ	Unpolarized Light.
1 reflexion at 53°, and 1 at 58° 2′ .	0° 12′ .	0.000024

This experiment requires a very intense light, for I find in my journal that the light of a candle is polarized at 53° and 78°.

In reflexions at different angles, the formula becomes $\tan\theta = \frac{\cos(i+i')}{\cos(i-i')} \times \frac{\cos(I+I')}{\cos(I-I')}$, I and i being the angles of incidence. In like manner if a, b, c, d, e, &c. are the values of φ or θ for each reflexion, or rather for each angle of incidence, we shall have the final angle or $\tan\theta = \tan a \times \tan b \times \tan c \times \tan d$, &c.

It is scarcely necessary to inform the reader that when a pencil of light reflected at 58° 2′ is said to be polarized by another reflexion at 67° 2′, it only means, that this is the angle at which complete polarization takes place in diminishing the angle gradually from 90° to 67° 2′, and that even this angle of 67° 2′ will vary with the intensity of the original pencil, with the opening of the pupil, and with the sensibility of the retina. But when it shall be determined experimentally at what value of φ, or rather at what value of Q the light entirely disappears from the extraordinary image, we shall be able by inverting the formula to ascertain the exact number of reflexions by which a given pencil of light shall be wholly polarized.

As the value of Q depends on the relation of i and i', that is on the index of refraction, and as this index varies for the different colors of the spectrum, it is obvious that Q will have different values for these different colors. The consequence of this must be, that in bodies of high dispersive powers, the unpolarized light which remains in the extraordinary image, and also the light which forms the ordinary image, must be colored at all incidences; the colors being most distinct near the maximum polarizing angle. This necessary result of the formula, I found to be experimentally true in oil of cassia, and various highly dispersive bodies. In realgar for example φ is $= 0$ at an angle of 69° 0′ for blue light, at 68° 37′ for green light, and at 66° 49′ for red light. Hence there can be no angle of complete polarization for white light, which I also found to be the case by experiment; and as Q must at different angles of incidence have different values for the different rays, the unpolarized light must be composed of a certain portion of each different color which may be easily determined by the formula.

Such are the laws which regulate the polarization of light by reflexion from the first surfaces of bodies that are not metallic. The very same laws are applicable to their second surfaces, provided that the incident light has not suffered previous or subsequent refraction from the first surface. The sine of the angle at which φ or Q has a certain value by reflexion from the second surface, is to the sine of the angle at which they have the same value at the first surface, as unity is to the index of refraction. Hence φ and Q may be determined by the preceding formulæ after any number of reflexions, even if some of the reflexions are made from the first surface of one body and the second surface of another.

When the second surface is that of a plate with parallel or inclined faces, its action upon light presents curious phænomena, the law of which I have determined. I refer of course to the action of the second surface at angles less than that which produces total reflexion. This action has hitherto remained uninvestigated. It has been hastily inferred, however, from imperfect data; and the erroneous inference forms the basis of some optical laws, which are considered to be fully established.

Among the various results of the preceding investigation, there is one which seems to possess some theoretical importance. If we consider polarized rays as those whose planes of polarization are parallel, then it follows that light cannot be brought into such a state by any number of reflexions, or at any angle of incidence, excepting at the angle of complete polarization. At all other angles the light which seems to be polarized, by disappearing from the extraordinary image of the analysing rhomb, is distinguished from really polarized light, by the property of its planes of polarization forming an angle with each other and with the plane of reflexion. At the polarizing angle, for example, of 56° 45′ in glass, the light reflected is 79.5 rays, and it is completely polarized, because the planes of polarization of all the rays are parallel; but at an angle of incidence of 80°, where 392 rays are reflected, no fewer than 157 appear to be polarized, though their planes of polarization are inclined 66° 26′ to each other, or 33′ 13′ to the plane of reflexion. This appearance of polarization, when the rays have only suffered a displacement in their planes of polarization from an angle of 90°, which approximates them to the state of polarized light, arises from the law which regulates the repartition of polarized light between the ordinary and extraordinary images produced by double refraction, and shows that the analysing crystal is not sufficient to distinguish light completely polarized from light in a state of approach to polarization. The difference, however, between these two kinds of light is marked by most distinctive characters, and will be found to show itself in some of the more complex phænomena of interference.

In my paper of 1815, already referred to, I was led by a distant view of the phænomena which I have now developed, to consider common light as composed of rays in every state of positive and negative polarization*; and upon this principle the whole of the phænomena described in this paper may be calculated with the same exactness as upon the supposition of two oppositely polarized pencils. Nothing indeed can be simpler than such a principle. The particles of light have planes, which are acted upon by the attractive and repulsive forces residing in solid bodies; and as these planes must have every possible inclination to a plane passing through the direction of their motion, one half of them will be inclined — to this plane, and the other half +. When light in such a state falls upon a reflecting surface, the — and the + particles have each their planes of polarization brought more or less into a state of parallelism with the plane of reflexion, in consequence of the action of the repulsive force upon one side or pole of the particle through which the plane passes; while in the particles which suffer refraction, the same sides or poles are by the action of the attractive force drawn downwards, so as to increase the inclination of their planes relative to the plane of incidence, and bring them more or less into a state of parallelism with a plane perpendicular to that of refraction.

The formulæ already given, and those for refracted light which are contained in another paper, represent the laws according to which the repulsive and attractive forces change the position of the planes of polarization; and as we have proved that the polarization is the necessary consequence of these planes being brought into certain positions, we may regard all the various phænomena of the polarization of light by reflexion and refraction, as brought under the dominion of laws as well determined as those which regulate the motions of the planets.

Allerly, December 25, 1829.

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* M. Biot has followed me in this opinion. See *Traité de Physique,* tom. iv. p. 304.

ART. V.—*Notice of new Medical Preparations; by* G. W. CARPENTER—*communicated by him.*

1. *Precipitated Extract of Bark.*

This extract contains quinine, cinchonine and the new organic alkali *chinioidine*; it possesses all the febrifuge properties of the quinine and can be afforded at about one third of the price.

In consequence of a scarcity of Peruvian bark in our market for some time past, quinine has likewise become scarce and its price nearly doubled. It is therefore highly important to the community, to obtain, at a less expense, a preparation of equal efficacy. The above extract will fully effect this object, and being the product of the same cinchona and containing, in addition to the quinine, other alkalies of the same bark, of at least equal efficacy to that of the quinine, it may be expected that after being fully tried by the faculty it will be adopted by them. Chemists and pharmaceutists have long thought that cinchona contains other active alkaline principles in addition to those already discovered in the bark, and the conclusive facts in relation to the use of quinine, of the entire bark and of the residuary extract, sustain this opinion; for many intermittents, which resisted numerous doses of six or eight grains of quinine, have yielded to the bark in substance. The late Dr. Emlen first used the residuary extract of bark, after the extraction of the quinine, and found that in doses of two grains it was quite equal to the sulphate of quinine: and Drs. Parrish and Wood, distinguished physicians of this city, have fully confirmed Dr. Emlen's experience.*

Dr. Sertürner, chemist, of Hamelin, likewise confirmed what has been observed by others, that, as a tonic, quinine cannot be substituted for cinchona, and made analytical researches on the bark to discover the cause of the difference. The precipitate obtained by treating the acidulous extract of cinchona by alkalies comprises, besides quinine and cinchonine, certain additional organic alkalies. These new organic alkalies, especially the principal one, which Dr. S. calls chinioidine, are intimately united with a sub-acid, resinous substance. The new alkali exists in the cinchona bark, associated with quinine and cinchonine, and they are all precipitated together in the above extract. The chinioidine resembles the other alkalies

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* See Journal of the Philadelphia College of Pharmacy, Vol. I, p. 44.

of cinchona in its solubility, color and taste; but it is distinguished from them by its activity, its greater capacity of saturation, its alkaline reaction, and its intimate combination with an extractive matter. Dr. Sertürner further states, that, as a medicine, chinioidine is one of the most precious agents of the materia medica. It is not only a better febrifuge than quinine, and even than the bark in substance, but it possesses many other therapeutic properties, which, admitting that they exist in the bark itself, are not to be found in quinine. It was prescribed by Dr. S. in the dose of two grains, three times a day. In all the cases, treated by the new remedy, the fever was cut short without relapse, and in every instance the concomitant symptoms, such as paleness of the face, loss of appetite, œdema of the legs, &c. disappeared in a shorter time than is usually the case. The medicine failed only in a single instance. The quantity necessary for a cure was generally from twelve to twenty four grains.*

The above extract is kept of two degrees of consistence; the soft can be made into pills with the addition of liquorice powder or starch, and the hard can be pulverized and made up with conserve of roses or syrup. It can be made into a solution in either state, with water, by the addition of one drop of sulphuric acid to each grain of the extract.

The following formula is an elegant mode of exhibition which produces a beautiful transparent solution.

R	Precipitated extract of bark, - -	48 grains.
	Acid sulphuric, - - - - -	40 drops.
	Alcohol, - - - - - - -	2 drachms.
	Aqua cinnamon, - - - - -	4 ounces.
M.		

Drop the sulphuric acid in the alcohol with about two drachms of water, which should be used to triturate and dissolve the extract, after which the remaining water should be gradually added. If alcohol is inconvenient it can be made without it, and common water can be substituted for the cinnamon.

MM. Henry and Delondre of Paris differ in their opinion with Sertürner, and consider what he denominates chinioidine to be a compound of quinine and cinchonine, associated with a peculiar yellowish substance of very difficult separation. I think the opinion of Sertürner to be correct, as it is supported by numerous pharmaceutical facts and characteristic properties of the substance. The peculiar yellowish substance of very difficult separation, described

* See Journal des Progres for 1829, Vol. III.

by Henry and Delondre, is no doubt also an active component of this extract, and we find in a number of vegetable crystalline products, that they frequently owe their activity to certain principles associated by their crystallization; and if rendered entirely pure, they are feeble or inert. Thus, piperine owes its activity to the resinous oil which is associated, more or less, with it; and in proportion as it contains this or is deprived of it, is its activity increased or diminished. It has been fully ascertained, that one drop of the oil is equal to three grains of piperine. Thus also it is with narcotine, which is more or less associated with a viscid substance, resembling caoutchouc, an acid and extractive matter in combination; and in proportion as the crystals are deprived of this combination, and are rendered pure and white, is its activity diminished. In the process of denarcotizing opium, this product is obtained with the narcotine, but it is not to narcotine that opium owes its stimulating and unpleasant properties, but to this compound. Magendie states that one grain of narcotine, dissolved in oil, has a powerful effect on the animal system, resulting in death. My experiment with narcotine differs exceedingly from the above, having given several grains without any sensible effect whatever, and a physician of this city, who has made a number of experiments on this salt, in a pure state, informs me that it possesses little or none of the narcotic or stimulating powers; that he took ten grains of it at once, and that it produced no other effect than a slight nausea, but associated as it is in its first extraction from opium with the peculiar substances before named, it possesses very active and deleterious properties.*

Quinine, when it was first made, contained a portion of extractive matter associated with it, and it is a fact well known to every physician who has employed this salt extensively, that it is not as active as it formerly was, and that it requires a larger dose for patients unaccustomed to the use of quinine.

We also know that the common manna is more active than the flake, and it could be so purified that it would not be more active

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* Dr. Tully, in a highly interesting paper on Narcotine, published in the XXI vol. of this Journal, although differing with me as to the degree of activity of this substance, states that it is less active on the human system, than opium itself. That from 2 to 5 grains constitute a medium full dose, where a single dose is to be taken. That it is entirely destitute of all stimulating powers, whether it is given in full or in moderate and uniform doses at regular and short intervals, but that it possesses soporific effects greater in proportion to its powers, than the sulphate of morphia.

He concludes by stating that he does not esteem it by any means, impossible that the bitter principle, or extractive (as vaguely called,) or perhaps some other part of this complex drug may yet be found to *contribute* something to its medicinal effects.

than white sugar. The seeds of the Palma Christi contain no doubt two oils, one bland and the other acrid, and in proportion as they are united by the difference in the process of manufacture, is this oil increased or diminished in activity; thus the cold expressed is more bland and less active than the hot pressed. The acrid oil resides in the skin of the beans and is obtained in greater proportion in the latter. If the oil were obtained from the skins alone, it would no doubt be as active as the croton, for if we swallow one or two of the beans, with the skins, the action is very powerful. I would by no means infer that in all cases of the combination of vegetable proximate principles such effects would result; we know, indeed, some instances to the contrary; but in the cases above referred to, there will probably be no diversity of opinion.

In relation to the precipitated extract of bark, I must further state, that I have endeavored to have it tried as extensively as possible, and the result has been most satisfactory; by many physicians it is preferred to the quinine, and they will probably use the latter rarely, when they can obtain this extract at so low a price.

I would wish it to be particularly understood, that this is not the same as that formerly sold under the name of extract of quinine, as it contains all the essential properties of the bark and is destitute of no principle except gummy matter, gluten and the woody fibre, which are inert.

2. *Oleo-Resinous Extract of Mustard or Oil of Sinapine.*

The seeds of the Sinapis nigra have been found, by long experience, to be one of the most useful of all the rubefacients. It is usually applied, as is well known, in the form of a paste, made with the farina of the seeds and vinegar, which is to be applied in the manner of a poultice. This is frequently attended with considerable difficulties and inconveniences; and mustard differs so essentially in quality, that little dependence can be placed upon the certainty of its effect. It is, almost always, more or less adulterated, and the flour which is sold from the stores is frequently composed of more than half foreign or inert matter. At the suggestion of our distinguished professor, Dr. Physick, I have made a series of successful experiments on the mustard, with a view of ascertaining the active constituent principle, and separating it, in a form best adapted for its application as a rubefacient. I have obtained, separately, the active principle of the mustard, which is combined with a volatile acrid oil.*

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* A full description of which will be given in the second edition of my Essays on the Materia Medica, shortly to be published.

This peculiar principle, in conformity to the usual nomenclature of vegetable proximate principles, I have denominated Sinapine. It bears the same relation to mustard that piperine does to pepper, and like it is united with an acrid oil, and is otherwise analogous to piperine in its chemical properties, in not forming salts with acids, &c. This differs essentially from the volatile oil obtained by distillation, being in every respect superior, and will entirely answer all the purposes of the mustard plaster, as a rubefacient. It is simply to be applied to the skin, and in a few hours all the effects of the mustard plaster will be experienced, and vesication may be produced by a second application of the oil. To the country practitioner this oil is very valuable: it is inconvenient to carry the mustard about the country; its activity is soon diminished, and even destroyed, so that, if not kept in a close bottle, it becomes inert. As country practitioners seldom carry this article with them, they are thus frequently deprived of the use of sinapisms, so important in some cases as to be essential to the life of the patient.

This oil is so concentrated a preparation that a small vial, which can be conveniently carried with the medicine usually taken by the physician, will be sufficient for several applications. As its action will always be uniform and it will not be liable to deteriorate in any length of time, it will be found, as a rubefacient, to be a valuable substitute for the crude mustard, and I hope will prove a valuable addition to the materia medica.* Philadelphia, Feb. 22, 1832.†

Postscript—*Philad. May* 25, 1832.—I have just observed a paper in the London Medical Gazette for Dec. 1831, in which Mr. R. Battley gives a detailed analysis of the cinchona. He finds it to consist of thirteen distinct principles, from quinine to the woody fibre. They all possess active properties, except three. The sulphate of quinine, in consequence of the absence of all the other properties above alluded to, can therefore be but partially efficient as a medicine. Thus the researches of Mr. Battley, have corroborated my statements in relation to the extractive matter of Peruvian Bark. This gentleman has suggested the propriety of using the liquor cinchona, as a medicine and maintained its decided superiority, since it contains all the principles of the bark above described, except the three objectional ones, viz. gummy matter, gluten and the woody fibre. This liquor Mr. Battley observes, is admitted by many competent judges, to be superior to the quinine; and as it is prepared by the same process as the quinine, which excludes these three principles, and contains all the rest, it would on evaporation, make precisely the same extract, as I have described under the name of the precipitated extract of bark.

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* Physicians can be supplied with the precipitated extract of Bark and Oil of Sinapine, at Geo. W. Carpenter's Chemical Warehouse, 301 Market St., Philadelphia.

† Intended for the April No. but did not arrive until it was finished.

Art. VI.—*Meteorological Table; by* Gen. Martin Field.

Extracts from a Meteorological Journal of Observations, made at Fayetteville, (Vt.) from the 30th day of April, 1831, to the 1st day of May, 1832, in lat. 42° 58′ N. and lon. 4° 20′ E. from Washington.

1831 and 1832.	THERMOMETER.											WEATHER.				WINDS.								MISCELLANEOUS.					
	Mean temp. at sun rise.	Mean temp. at 2 o'clock, P. M.	Mean temp. at 9 o'clock, P. M.	Aggreg. of mean temp. each month.	Maximum of temperature.			Minimum of temperature.			Range of Therm'r	No. of days of diff. variation.																	
M'ths.					Day.	Hour.	Highest degree.	Day.	Hour.	Lowest degree.		Fair.	Cloudy.	Rainy.	Snow & hail.	N.	N. E.	E.	S. E.	S.	S. W.	W.	N. W.	Inches of water in rain, snow & hail in day time.	Inches of water in rain, snow & hail at night.	Aggregate of water each month.	Inches of snow & hail.	Lightning & thunder. No. of days.	Aurora Borealis. No. of nights.
May	48.	64.	54.6	55.5	29	3 P. M.	84°	10	5 A. M.	33°	51°	19	12	6	1	1	2	1	2	9	2	7	7	2.8	2.	5.8	hail .5	2	2
June	59.3	78.2	65.1	67 3	10	2 .	90	24	4 .	38	52	16	14	14	—	1	5	—	2	7	7	3	5	3.	1.7	4.7	—	8	2
July	60.8	79.	66.	68.6	4	4 .	88	12	4 .	43	46	17	14	11	1	3	2	3	1	5	5	9	3	4.4	1.	5.4	hail 1.5	7	7
Aug.	58.6	80.	66.4	68.3	15	3 .	94	29	5 .	38	56	20	11	4	—	2	4	1	1	3	6	3	11	1.5	2 8	4.3	—	5	1
Sept.	51.5	67.3	55.5	58.1	11	2 .	85	30	6 .	38	47	19	11	6	—	2	—	—	2	8	4	7	7	3.9	4.8	8.7	—	2	—
Oct.	43.	58.6	47.7	49.8	3	2 .	76	29	6 .	24	52	21	10	6	—	3	5	—	1	6	5	5	6	3.8	3.2	7.	—	—	1
Nov.	32.3	42.6	34.7	36.5	1	2 .	65	30	7 .	6	59	20	10	3	3	—	5	—	—	3	3	5	14	2.	2.	4.	12.	1	—
Dec.	4.5	15.4	5.	8.3	24	9 .	31	31	8 .	-17	49	19	12	—	6	1	5	—	—	1	5	5	14	.6	1.4	2.	17.	—	—
Jan.	13.5	25.5	18.1	19.	19	2 .	45	28	7 .	-20	65	20	11	2	7	2	2	1	—	5	5	6	10	1.5	4.2	5.7	31.	—	1
Feb.	14.	26.	19.	19.3	3	2 .	45	25	7 .	-20	65	14	15	2	9	1	4	—	1	3	5	4	11	1.5	1.5	3.	36.	—	—
March	20.5	36.7	27.7	28.3	31	3 .	56	2	6 .	- 6	62	22	9	3	3	—	4	—	1	5	7	5	9	1.8	2.	3.8	9.	1	1
April	29.8	48 5	36.1	38.1	26	3 .	80	9	5 .	10	70	20	10	5	3	2	6	1	2	1	3	7	8	2.7	1.5	4.2	9.	1	—
Ag.tem	36.3	51.8	43.1	43.4	*Recapitulation.*							227	139	62	33	18	44	7	13	56	57	66	105	29.5	28.1	58.6	116.	27	15

Remarks.—From the foregoing table it appears, that the mean temperature of the twelve months past was 43.4°. The temperature of the summer months was 68°—that of the winter 15.5°—difference 52.5°, which is much greater than usual in this latitude. On the evening of the 31st of Dec. the mercury rose to 31°, but at no other time from the 28th of Nov. to the 6th of Jan. did it rise above 24°. The mean temperature of the month of Dec. was 8.3°, which was precisely 5° below that of the extreme cold month of Feb. 1829; and was probably colder than any other month, within the last half century. The highest temperature within the year was on the 15th of August—and was 94°,—the lowest was 20° below zero, and was the same on the 28th of January and on the 25th of February—range of thermometer 114°. The mercury fell below 0 fifteen nights in December—seven in January—six in February—and one in March, being twenty nine nights during the winter. The quantity of water, which fell, in rain, hail and snow during the year was 58.6 inches, and very near the same which fell the year preceding. The quantity of snow and hail was 116 inches (9ft. 8in.) which was four feet more than fell in the winter preceding, and much more than I can find recorded in my journal of any former year. We had good sleighing from the 26th of Nov. to the last week in March, and there is yet much snow in drifts and shaded places on the high lands. The aurora borealis was seen on fifteen nights only, during the year, which was forty one less, than in the twelve months preceding. Nothing unusual in the appearance of the aurora was observed, during the year, except on the morning of the third of July. I first discovered it, at about one o'clock, at which time the northern part of the heavens was brilliantly illuminated. Pencils of rays shot up towards the zenith, some of which were accumulating and others were dissolving, as they moved rapidly from east to west. But that which rendered the scene peculiarly interesting was the color of the rays. Each pencil, for a considerable distance from its termination, exhibited a beautiful crimson color; while the lower part of these pencils, and the broad arch, which appeared to sustain them, at about 25° above the horizon, were of a yellowish white light. The rapid succession of different colored rays, and the great extent in the heavens which this aurora covered, rendered the exhibition beautiful and sublime beyond description. The thermometer at the time stood at 68°—light breezes from the south—the sky was a little hazy and the atmosphere thick and humid. The days before and after this northern aurora were showery and attended with lightning and thunder. The twelve months past have been peculiar for sudden changes of the atmosphere, and extremes of heat and cold. The temperature of the summer months was about 3° above that which is usual in this latitude, yet we had frosts in every month; (viz) on the 24th and 25th of June, on the 12th of July and on the 29th of August; but not so severe as to be injurious to vegetation.

We had fourteen cloudy and rainy days in June, and the same number of cloudy and eleven rainy days in July, the consequence of which was the most luxuriant growth of grass. But the hay crop being generally washed, and not sufficiently dried, was less valuable than usual, in proportion to the quantity obtained. The Indian corn crop was abundant, and on the low lands it ripened in the month of August. The season was too warm and humid for potatoes, and the crop came in light—rye, oats, &c. suffered extremely by blight. In the vallies fruit trees of every kind were tolerably productive, but on high lands very little fruit was obtained.

Fayetteville, Vt. May 1, 1832.

Art. VII.—*Observations on the Primitive and other Boulders of Ohio; by* Darius and Increase A. Lapham.

It is well known, that large rounded masses of primitive, and other foreign rocks, lie scattered over the secondary regions of the West. This subject has of late years, received much attention from geologists; and many very ingenious theories have been, at various times invented and proposed to account for their origin and to show the means by which these "lost stones" have been removed to so great a distance from their original beds. We will not stop here to enumerate all the various theories (many of which are now laid aside) but will proceed to state such facts as have come under our observation and the conclusion to which they have "irresistibly" brought us.

The bed and banks of the Ohio river are composed in part of gravel or water worn fragments of rock. The kinds of rock called granite and greenstone (one a primitive and the other a superincumbent rock) which are not found in the neighboring hills, nor indeed any where within the great *basin* of the river, forming the greater proportion of this gravel. The first inquiry which presents itself in reflecting on this subject is, whence came all this granite and greenstone? Our curiosity is excited and we examine the subject further. This same kind of gravel is discovered mixed with clay and sand forming banks and even hills of moderate elevation that are entirely beyond the influence of the Ohio or any other existing current of water. It is evident therefore that we must seek some other and mightier cause for the wearing down and removal of these pebbles. But these banks appear to be the kind which geologists call *diluvial;* they consist of layers more or less distinct which are always curved or bent and variously distorted. The gravel is generally cemented by a stiff blue clay and is then called *hard pan*, but occasionally by carbonate of lime into a kind of *pudding-stone*. This is then *diluvial* earth* and agreeably to the opinion of most geologists has its origin in some *flood* or *deluge*.

If we travel hence, in a northern direction, this kind of earth becomes more and more common, till on the Sandusky plains it is the subsoil of the whole country. It sometimes covers the underlying rocks to the depth of eighty or a hundred feet, as may be seen at the Bluffs near Circleville. At this place the Ohio canal is constructed along the base of a steep diluvial bank in such a manner that the strata are beautifully exposed for a distance of two miles. The clay found in this bluff is of two kinds—one a deep blue containing many fragments of a dark colored *argillite* with other kinds of gravel. It has probably resulted from the destruction of this kind of rock. The other is a yellowish kind of clay which covers the strata below in a non-conformable position. It contains fragments of the common limestone and sandstone of Ohio which are not much worn.

The attentive observer will discover also, in travelling to the north that the gravel forms a larger proportion in the composition of the diluvion and that the fragments are larger. In general when they exceed the size of one's head they are called *boulders* by geologists; but there is no distinct mark by which they are separated—they gradually *pass into* each other, and it is not always easy to determine whether a particular stone should be called a boulder or a gravel stone. Proceeding still further north the boulders become more numerous; they are of larger dimensions and generally less rounded by attrition.

From all these facts it is evident that we must look beyond the Great Lakes for the origin of our primitive fragments, and it only remains, to point out the precise locality from which they have been removed and the question would be settled. We should then know every thing concerning them. But as our observations have not been extended into that region and as we have no books describing the rocks there, we must leave this to future observers.

The surface of this immense deposit of diluvion every where presents a wave-like undulated appearance. These swells are gen-

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* Or perhaps tertiary as well as diluvial.—*Ed.*

erally more abrupt about Circleville than north of it. One elevation near that place has been mistaken for an ancient artificial mound. In many places the soil is not very inviting to the agriculturist: only a stinted growth of oaks and hickories is to be met with. Occasionally a low place is too wet even for these and only a few sub-aquatic weeds and grasses are found. These last places become larger as we go northward and there assume the name of prairies. The diluvion extends to the lakes and probably some distance into Canada.

The boulders occur most frequently in the beds of ravines and of rivers and the tops of hills. They seldom occur on the surface of the diluvion where it remains entire; but upon descending into the bed of some stream or rising a hill they may be seen in abundance. It would appear that the earth in these situations has been washed away leaving the more ponderous boulders exposed to view.

At the Circleville bluffs the boulders were not allowed to form a part of the bank and were therefore collected in large piles by the workmen. Here then is an excellent opportunity for examining and comparing them. They also have the advantage of having been taken fresh from the bank, and are therefore free from the effects of the weather. We are not sufficiently familiar with the characters of primitive and transition rocks and the minerals which they contain, to undertake a description of each kind found here. This we have often regretted, as it would be quite interesting and highly useful in determining the precise localities from which they came. It is hoped that some more experienced geologist will ere long visit this locality. Granite, gneiss, horblende rock, greenstone, argillite, &c. are mixed profusely with secondary rocks containing petrifactions of shells and madrepores. The largest boulder which we have seen was on the summit of a hill near Lancaster and was about six feet in length—we have heard of others much larger.

Of the cause of this great flood which has at some very remote period swept down from the north and inundated the whole country it would be in vain to speak. We are convinced that such a flood has existed and that it has been the cause of the removal of our primitive fragments from their original beds. All the facts connected with the subject may be satisfactorily accounted for in this way.

In an interesting paper by the Hon. Judge Tappan inserted in the 14th Vol. of this Journal, it is stated that a variety of trap or greenstone is the only rock which is found "rounded and smoothed by attrition," and that these rarely occur, except "in the valleys of rivers." We would add that granite and many other rocks are always found rounded as well as greenstone; but they are not at present always smooth. This is owing to their surface having been disintegrated and left rough by the action of the weather, while greenstone, which is firmer in its texture, has not been operated upon by this cause. It is true that they occur most abundantly in water courses, but they are also to be found in great numbers on the hills as has already been explained. No one can suppose that the boulders and gravel which now line the beds and banks of the rivers in Ohio could have been rounded and smoothed by the action of the currents of those rivers.

In a letter accompanying the above notice it is observed that the expression primitive boulders commonly employed does not accurately describe the fact, since some of these boulders are secondary.

There is an interesting connexion between the boulders, and the diluvion which has sometimes been overlooked. For example, at the bluffs, a few miles below Circleville, in the various and very curious windings and turnings of the different layers of clay, sand and gravel, large quantities of boulders have been found by digging, and the gravel is nothing more than boulders on a smaller scale. Is not this conclusive as to the origin of the boulders?

Art. VIII.—*On the method of tracing oval arches from several centres*; by Edward Miller, A. M. Civil Engineer.

The difficulty of describing an Elliptical arch of great span, makes it important to find a curve, which, resembling the Ellipse in its graceful and convenient form, may be constructed with greater ease and accuracy. Oval arches are frequently formed by three arcs of circles; the radii of two being equal, and their centres situated in the transverse axis; while the middle arc has a longer radius, and the centre in the line of the conjugate.

Several methods of tracing ovals from three centres are given in the elementary works on Carpentry, &c. But when the difference between the rise and half-span is considerable, the change of curvature becomes very perceptible and unpleasant to the eye, and it is advisable to employ a greater number. This has been done by the French in the construction of some of their finest bridges. A beautiful example is Neuilly, built by Perronet, and traced from eleven.

The following conditions are (fig. 1.) laid down by the French Engineers, in order to avoid the indetermination of the problem.

1st. The number of centres shall be uneven.

2nd. The sum of the arcs shall be 180°. The two arcs of smallest radius shall have their centres on the transverse diameters, and the arc of greatest radius shall have its centre in the line of the conjugate.

3rd. *pc*, the distance from the centre of the oval to the centre of the middle arc, shall be three times *pa*, the distance from the centre of the oval to the centre of the arc of smallest radius.

4th. *pa*, the distance above mentioned, shall be divided by the radii of the other arcs into parts which are to each other in the ratio of the natural numbers 1, 2, 3, 4, &c. In all cases deduct one from the number of centres to be employed, and half the remainder will give the parts into which *ap* must be divided.

5th. The distances between the prolongations of the radii measured on the conjugate axis produced, shall be equal.

The following method of determining the point *a*, was discovered by my friend Benjamin Aycrigg, Civil Engineer, and is I believe the best and most simple.

He supposed the concentric curve *ao*, (fig. 2.) to be drawn commencing at the point *a*, with the radius *i a*. Then it will be perceived on an examination of the figure that we have sufficient data to calculate all the angles contained within the curve *a o*, and all the radii and lines in terms of *ap*. Suppose this done and the line *op* to be found. Then because the curve *a o* is concentric to the curve *b d*, the lines *a b*, *a h*, *rg*, *o d*, &c. are all equal. Let each of them $=x$, and in order to construct an arch of any given rise and span, we have this proportion, $(op+x) : (pa+x) ::$ rise : semi-span; whence the value of $x=ab=od$, is easily found in terms of *ap*, so as to give *p d*, and *p b*, in the required proportion. Having this we can of course find the value of the radii and other required lines in terms of the rise and span.

In these ovals it will be observed that the value of all the lines and angles within the curved line *a o*, are general, and when once calculated will serve for all arches. I shall now proceed to give these general calculations for curves of 5, 7, 9, and 11 centres. That of 7 was computed by Mr. Aycrigg, the others by myself. Their accuracy has been abundantly tested in various constructions. The Alleghany Portage Rail road, on which I am at present engaged, has twelve oval arches; four of which are, of forty feet span, one of twenty five, one of twenty, &c. In fact the great facilities afforded for tracing the curves, and cutting the joints of the voussoirs normal to them, must cause their adoption wherever they are known.

Five Centres. (Fig. 3.)	*Seven Centres.* (Fig. 4.)
$ab=1.$	$AB=6.$
$bA=2.$	$AD=18.$
$AB=4.50$	$ab=1.$
$AC=9.00$	$bc=2.$
$ca=2.704$	$cA=3.$
$cb=2.305$	$Dc=18.252$
$bd=0.399$	$ec=8.111$
$Ce=9.619$	$eb=8.667$
$Ae=0.619$	$db=1.857$
$Cb=9.220$	$da=2.425$
$dca=21° 9' 40''$	$bf=0.567$
$eCd=12° 31' 44''$	$cg=1.124$
$AaB=56° 18' 36''$	$Ah=1.376$
	$ADc=9° 27' 45''$
	$ACb=22° 37' 12''$
	$ABa=45°$
	$ceb=13° 9' 27''$
	$bda=22° 22' 48''$

Nine Centres. (Fig. 5.)

$Aa=10$	$ea=2.273$
$AB=7.5$	$bh=0.683$
$AE=30$	$ci=1.507$
$ab=1$	$dk=2.155$
$bc=2$	$Am=2.423$
$cd=3$	$AEd=7° 35' 41''$
$dA=4$	$dgc=9\ 41\ 12$
$Ed=30.268$	$cfb=13\ 40\ 57$
$gd=17.025$	$bea=22\ 9\ 58$
$gc=17.673$	$AaB=36\ 52\ 12$
$fc=7.250$	$AbC=59\ 2\ 10$
$fb=8.074$	$AcD=72\ 43\ 7$
$eb=1.590$	$AdE=82\ 24\ 19$

Eleven Centres. (Fig. 6.)

AB= 9	nm=	2.187			
AF=45	ul=	0.762			
Am=15	tk=	1.798			
mu= 1	si=	2.778			
ut= 2	rh=	3.488			
ts= 3	Ag=	3.765			
sr= 4	AFr=	6°	20′	25″	
rA= 5	rgs=	7	41	45	
Fr=45.277	spt=	9	55	36	
gr=28.98	tou=	13	54	44	
gs=29.69	unm=	21	9	40	
ps=15.90	ArF=	83	39	35	
pt=16.88	AsE=	75	57	50	
ot= 6.568	AtD=	66	2	14	
ou= 7.604	AuC=	52	7	30	
nu= 1.425	AmB=	30	57	50	

* * * * *

In a letter from Mr. Miller accompanying the above communication, and dated April 7th, 1832, it is suggested by him that it would be very important to the country if practical men would make known through a Journal of Science, "such things, as in the course of their experience they judge may be especially useful to their professional brethren," while every thing that is erroneous or useless should be of course rejected. Mr. Miller goes on to remark: "Civil Engineering is now becoming, from the numerous public works in the United States, a distinct and important profession. It is one in which a large amount both of science and experience is required and in which the members are able to assist each other greatly, by making known the results of their labors. In England this object is attained by an "Institution of Civil Engineers," which however desirable, is hardly to be expected in a country like our own where they are so widely scattered.

I have taken the liberty of asking your attention to this subject, as I believe that a public call would bring out a large portion of the talent and experience of our profession.

The enclosed paper on Oval Arches was drawn up by myself for my own convenience and is copied nearly verbatim from my common place book. I know of no work which gives a satisfactory view of the subject; and am sure that the general calculations have never before been published. They were made some years ago with much care and their accuracy has been repeatedly tested by experi-

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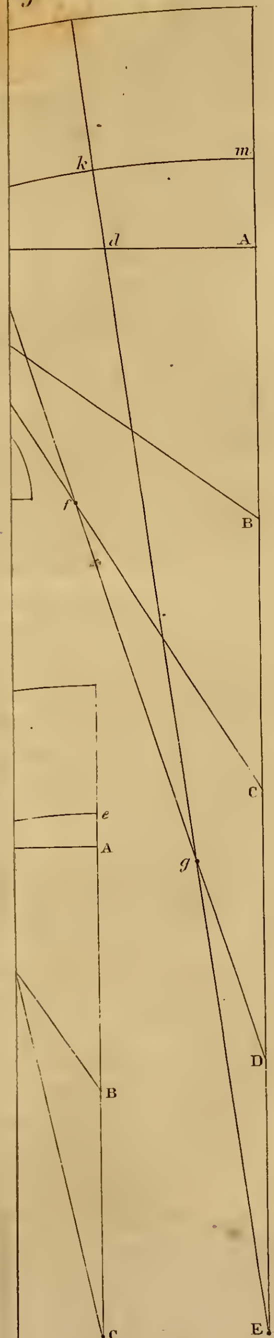

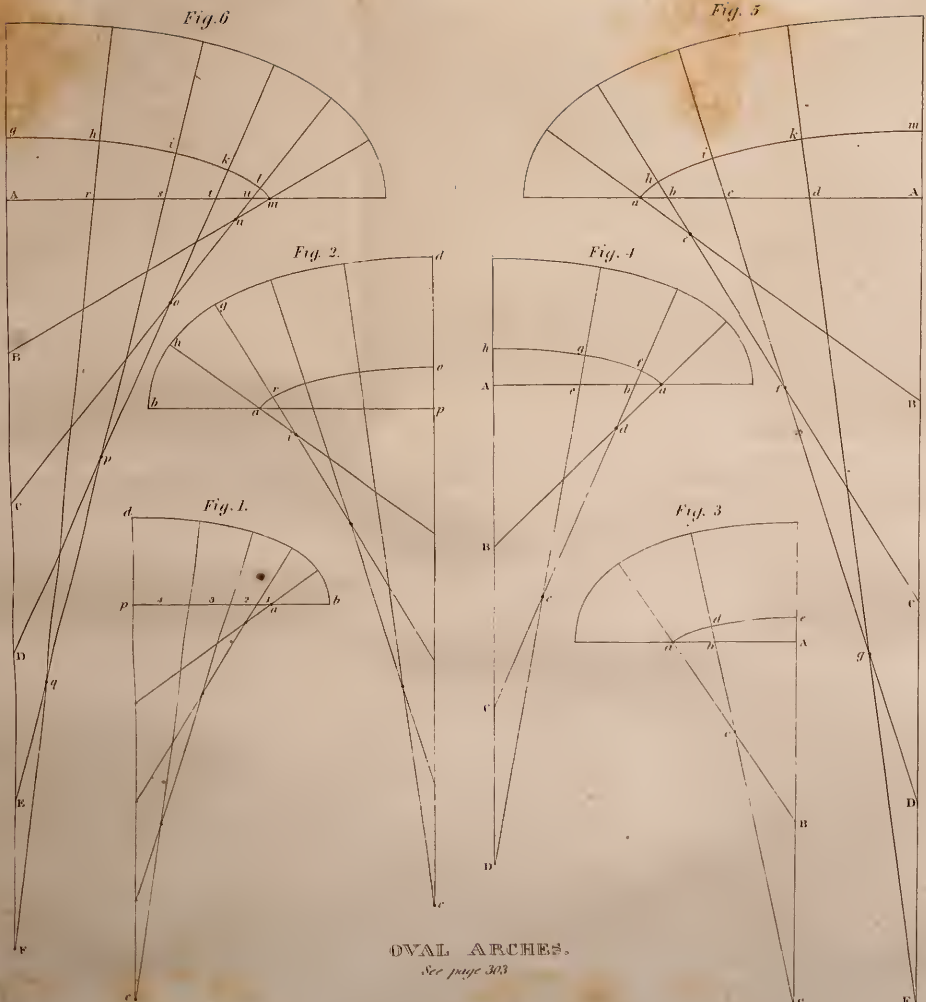

OVAL ARCHES.

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ment. I think they will be found very useful to Engineers and Architects."

We coincide fully with Mr. Miller as to the importance of eliciting this species of knowledge, in our country, and the Editor will feel much obliged by communications on this subject from all able Engineers who may deem this Journal a suitable vehicle for their observations.

Art. IX.—*On the Chemical Composition of the Brown Lead Ore; by* C. Kersten, *of Freyberg.* Translated from the German of the Neues Jahrbuch der Chemie und Physik, Band II. Heft 1. by Charles U. Shepard.

In the following brief memoir, I am permitted to give, in succession according as they were obtained, the results of a chemical analysis of the principal varieties of the Brown Lead Ore from various localities,—commencing with a short historical notice of that variety which from its interesting chemical composition led to these inquiries.

Several months ago, there was found in the Sonnenwirbel mine at Freiberg a mineral, which in its external appearance resembled the so called, botryoidal Brown Lead Ore, but which presents an essential difference in its inferior specific gravity. Prof. Breithaupt subjected it to a mineralogical examination, and communicated a description of its external characters in the third number of this Journal for 1830, from which the following account is borrowed. This mineral occurs in distinct balls and globular masses, whose interior exhibits a fine concentric texture; in consequence of which, Prof. Breithaupt was led to denominate it *Polysphärite.* It belongs, according to him, to the order of Spar, but to the order Baryte in the system of Mohs. It possesses a greasy lustre, and a brown color which runs from a clove-brown into Isabella-yellow. It occurs only in balls and globular masses, upon whose exterior are seen small, but undeterminable crystals. These masses rarely unite to give rise to kidney-shaped pieces. It presents a moderate degree of lustre, and an asteriated or radiating fracture, which sometimes becomes nearly invisible, and from thence passes to the compact conchoidal fracture. Its hardness =4, according to the scale of Breithaupt, or 3 by the standard of Mohs. Its specific gravity, when perfectly free from foreign substances =6.092.

For our earliest notice of this mineral, we are indebted to Mr. *Freiesleben*, Counsellor of mines, who in his Geological Researches (Bd. VI. S. 148—150) separates it from the true Brown Lead Ore, treating it as an appendix of that ore, and giving a complete mineralogical account of its properties. The collection of minerals formerly belonging to Mr. Freiesleben, and now in the possession of the University of Moscow, contains four specimens of this mineral. These specimens are alluded to by Mr. Fischer, Counsellor of state,* under the name of *reniform* Brown Lead Ore. From whom we learn also, that it had been found, before its discovery at Freyberg, at Johanngeorgenstadt and at Mies in Bohemia.

As the specific gravity of this mineral—5.836 to 6.092—is notably lower than that of the so called, Green and Brown Lead Ore, which according to Mohs, in a yellowish green specimen from Johanngeorgenstadt amounted to 7.208, in a green one from Zschopau, 7.098, and in the variety examined by Wöhler from the same locality, as ascertained by Rose, equalled 7.054, it appeared very probable that there would be found to exist a difference in chemical constitution between these two minerals. And the conjecture seemed very probable, that the Polysphärite might present a different saturating proportion of its constituents from the Green and Brown Lead Ore, or that the base of the latter might be replaced in part in the former, by another base specifically lighter. With a view to settle this point, I have subjected the Polysphärite to an accurate analysis; having for this purpose obtained of Mr. *Von Weissenbach*, Surveyor of mines, specimens of the most perfect purity.

Preliminary Trials.

Alone before the blowpipe, this mineral melts at first only upon its outer edges; it then swells up, and at last, with a strong blast of the instrument, it melts into a white enamel-like mass. During the experiment, the flame of the candle is tinged green upon its edges. If small fragments of the mass are placed upon a bead of salt of phosphorus, and this salt is heated again, there arises a lively effervescence, and we perceive the smell of muriatic acid. Fused with soda, it afforded metallic lead and a brown, semi-fused slag. No odor of arsenic was perceived during these trials.

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* *Musée d'histoire naturelle de l'université Imp. de Moscow, par Fischer* de Waldheim. Tome II, p. 297.

Phosphate of iron and metallic lead were obtained, with boracic acid and iron. The mineral was completely dissolved at an ordinary temperature in nitric acid, unattended with effervescence and without leaving any residue behind. The solution formed a colorless liquid, from which, in the cold, were deposited after the nitrate of lead, the chloride of lead in long needle-like crystals. The decanted solution exhibited the following properties.

Nitrate of silver gave a dense precipitate of chloride of silver. A stream of sulphuretted hydrogen produced a dense brown precipitate, which farther enquiry showed to consist wholly of sulphuret of lead. By continuing the passage of this gas for a longer time, a slightly yellowish precipitate of sulphur made its appearance.

Hydro-sulphuret of ammonia threw down from the solution, which had been completely freed from lead by sulphuretted hydrogen, a white precipitate, which I at first took for alumine, as indications of this base had been noticed in experiments with the blowpipe. A closer examination, however, proved that this precipitate consisted of a phosphate of lime with excess of base. In order fully to determine the presence or absence of alumine, I fused together, after the method of Berzelius, two parts of the mineral with six of carbonate of soda and one and a half of silica, and dissolved the resulting mass in water. The insoluble portion being treated with muriatic acid, the silica separated as usual, and the filtered liquid tested for alumine, no trace of this base was afforded; but on the contrary, it was found to contain *lime.* From the solution of the mineral wholly freed from lead by sulphuretted hydrogen, sulphuric acid threw down a voluminous precipitate, which was partly dissolved in a large excess of water; which solution was much troubled by the addition of oxalate of potash. The solution, after the precipitation of the lime, being mingled with alcohol for the complete separation of the sulphate of lime, was found to contain no additional bases. Nitrate of silver produced in it a yellow precipitate, soluble in caustic ammonia and nitric acid.

For the purpose of ascertaining whether fluoric acid was an ingredient in this mineral, one gramme of it was heated with sulphuric acid in a platina capsule. A glass plate held over it, manifested after the experiment, a distinct corrosion. This striking appearance induced me to repeat the experiment for a number of times, which was always attended with the same result; and the presence of fluoric acid was thus proved to a certainty. The following, therefore, are the constituents of this mineral; viz. *lead, lime, phosphoric acid, chlorine* and *fluorine.*

Analysis.

The determination of the quantitive composition of the Polysphärite was effected by means of three analyses, made with the utmost possible care, in which the method of proceeding was as follows.

(*a.*) One gramme of the finely powdered mineral was dissolved in the cold, in order to prevent the escape of any muriatic acid; and the solution, diluted with water, was precipitated by nitrate of silver. According to the mean of three trials, the quantity of chloride of silver obtained was 0.106, which corresponds to 0,0200 of muriatic acid,* or to 0.01765 of chlorine.

(*b.*) After the precipitation of the chloride, and the removal of the excess of nitrate of silver from the liquid by means of muriatic acid—the precipitate thus obtained being carefully washed with distilled water—a stream of sulphuretted hydrogen was passed through the fluid, and the sulphuret of lead obtained was estimated. In two experiments the sulphuret of lead was converted into sulphate of lead, by means of concentrated nitric acid. These precipitates corresponded to 0.7217 of oxide of lead, or to 0.670 of metallic lead.

(*c.*) The lime was thrown down, by means of sulphuric acid, from the liquid remaining after the precipitation of the lead, after that I had warmed, filtered and mingled it with alcohol. The voluminous precipitate obtained was separated by the filter: the liquid was somewhat concentrated, and the sulphate of lime thus obtained added to the first precipitate; and the whole dried and ignited. Its weight amounted to 0.1558, which corresponds to 0.0697 of lime. As the proportions of chlorine, lead and lime in this mineral were ascertained by three analyses, so also, the proportions of phosphoric and fluoric acids were found, through the loss of weight in these processes.

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* As these researches sustain a peculiar relation to those of Mr. Wöhler upon the composition of the Green Lead Ore, and to those of Mr. G. Rose upon the chemical constitution of the Apatite, I have, for the sake of favoring a comparisen, employed in this memoir the same determinations, for the most part, as were made use of by those chemists.

These analyses yielded, in 100 parts:

Oxide of lead, - - - -	72.17
Lime, - - - -	6.47
Muriatic acid, - - - -	2.00
Phosphoric and fluoric acids, with loss,	19.36
	100.00

If we observe the results of the foregoing analyses, we cannot fail of discovering a great resemblance between them and those obtained in the examination of the Phosphates and Arseniates of Lead by Mr. Wöhler;* while on the other hand, a remarkable difference will also be perceived. The Brown Lead Ore just examined, besides the customary constituents, contains also *fluoric acid* and *lime*, neither of which have before been found as constituents in the Phosphate of Lead, and forms therefore, a constant and fixed compound of substances, whose union together in minerals was before unknown. We may nevertheless form a correct idea of the manner in which chlorine, fluorine, phosphoric acid, calcium and lead are united in this mineral, when we take into consideration the results of the researches of Mr. Wöhler upon the Phosphates and Arseniates of Lead, and those of Mr. G. Rose upon the Apatite, which afforded us our first knowledge of the interchanging relations of these minerals. From the former of these, it follows, that the Green Lead Ores are compounds of 1 atom chloride of lead and $3\frac{2}{3}$ atoms phosphate or arseniate of lead; and that the phosphoric and arsenic acids are so mixed in variable proportions in the compound, that they may completely replace each other, without giving rise to any modification in crystalline form, or to the relative proportion of the lead in the basic salts to that in the chloride of lead. The investigations of Mr. G. Rose concerning the chemical constitution of the Apatites, prove that these are isomorphous with the Phosphates and the Arseniates of Lead; and that one and the same chemical formula expresses the composition of both species, viz.

$$R\left\{\begin{matrix}\bar{C}l\\ \bar{F}\end{matrix}\right. + 3R^{3}\left\{\begin{matrix}\dddot{\bar{P}}\\ \dddot{As}\end{matrix}\right.$$

In this formula R stands for radical, and the Apatites differ from the Green Lead Ores in their chemical relations only in this respect,—that chlorine and fluorine replace each other in the first, and phos-

* Poggendorff's Ann. d. Ph. u. Ch. Bd. IV. S. 161.

phoric and fluoric acids, in the last. Calcium is the radical in the Apatites, and lead in the Green Lead Ores. If we compare the results of the researches alluded to with those of the present analysis, we at once perceive in what a near relation the former stand to the latter; and that the Polysphärite appears to be only a Green Lead Ore, in which a part of the lead is replaced by lime, and a part of the chlorine by fluorine, or in which chlorine and fluorine, lead and lime are isomorphous with each other. Although we may in this manner arrive at a probable conclusion respecting the mode of composition in this mineral, and comprehend the relation of the chlorine and fluorine compounds to the basic salts, yet the kind of combination in the union of the chlorine and fluorine with calcium or with lead, remains to be explained. We may assume, for instance, that in the mineral under consideration, chlorine and fluorine are in common united with lead; in which case the formula of the mineral will be,

$$\text{Pb}\left\{\begin{matrix}\overline{\text{Cl}}\\ \overline{\text{F}}\end{matrix}\right. + 3\left\{\begin{matrix}\dot{\text{Pb}}^3\\ \dot{\text{Ca}}^3\end{matrix}\right\}\ddot{\overline{\text{P}}}$$

or even, that the chlorine is united with the lead to form chloride of lead, and the fluorine with the calcium to form fluoride of calcium; in which case the chemical composition of this mineral would be represented by the following formula:

$$\left.\begin{matrix}\text{Pb}\,\overline{\text{Cl}}\\ \text{Ca}\,\overline{\text{F}}\end{matrix}\right\} + 3\left\{\begin{matrix}\dot{\text{Pb}}^3\\ \dot{\text{Ca}}^3\end{matrix}\right\}\ddot{\overline{\text{P}}}$$

Additional circumstances, of which I shall make mention in the conclusion of this memoir, particularly the circumstance that in all the inquiries respecting the varieties of the Brown Lead Ores, every one examined by me that was found to contain fluoric acid contained lime also, and on the other hand, those which were deficient in lime, were in like manner wanting in fluoric acid, serve to render the latter supposition concerning the way in which the constituents of this mineral are united as the most probable one. If we adopt this formula, we can easily ascertain, by means of Berzelius's new table of equivalents, the quantity of fluorine, or of phosphoric and fluoric acids, which the Polysphärite contains, and which were not determined in the analysis. By means of a simple proportion, founded upon the quantities of oxide of lead and chlorine, found in the analysis, we derive the proportions of fluoride of calcium and basic phosphate of lime; from whence

The chemical composition of the Polysphärite reckoned after the last mentioned formula is as follows:

Chloride of lead,	10.838	containing	8.073 lead.
Fluoride of calcium,	1.094	"	0.567 calcium.
Basic phosphate of lead,	77.015	"	58.918 oxide of lead.
———————— lime,	11.053	"	6.025 lime.
	100.000		

The result thus obtained, not only confirms in the highest degree the supposition which we have made respecting the mode of combination among the constituents, but shows at the same time the correctness of the chemical analysis; since the quantity of lime as ascertained from calculation corresponds very well with that found by analysis, when we take into consideration, that the determination of the base could not, in the present instance, be so accurately ascertained as that of the chlorine and of the oxide of lead.

But if we adopt the view, that the fluorine in this mineral, instead of the chlorine is united to the lead, which, however, I have already remarked is the less probable state of the case, and if we enter into a similar computation as above, founding the estimate upon the quantities of chlorine and oxide of lead ascertained from the analysis, we have the following as the chemical constitution of the Polysphärite:

Chloride of lead,	10.838	containing	8.073 lead.	66.991.
Fluoride of "	3.398	"	2.871 "	
Basic phosphate of lead,	73.255	"	56.047 "	
———————— lime,	12.509	"	6.815 lime.	
	100.000			

As the preceding chemical examination of the variety of Brown Lead Ore, called Polysphärite shows, that in it, a part of the chlorine is replaced by fluorine without occasioning a disturbance in the constituents, or a variation of the formula which expresses the composition of the Green Lead Ore, it appeared highly probable, that calcium and fluorine might enter into the constitution of more varieties of Green and Brown Lead Ore.

This induced me, in the first place, to analyze more Brown Lead Ores from different localities; and I especially directed my attention to such as were possessed of a diminished specific gravity.

As I have pursued the same method of investigation as has been detailed above, I shall refrain from mentioning the individual steps taken in the following analyses.

2. *Botryoidal Brown Lead Ore of Mies.*—It occurs at Mies, in Bohemia, in a gangue of clay slate with argentiferous Galena, Quartz and Brown Lead Ore of other varieties as respects form and color. The specimen employed in this examination forms botryoidal and globular masses of the size of a pea. The globules were attached to Galena, and exhibited within a liver-brown color, which passes into yellow. They were rough and sometimes crystalline upon their exterior,—always possessing a conchoidal fracture. The specific gravity of this variety was 6.444. Powdered crystals of it, heated with sulphuric acid in a platina capsule, occasioned a very strong corrosion upon a glass plate held over the vessel.

Heated before the blowpipe in platina forceps, the mineral melted, and crystallized on cooling. The flame of the blowpipe was very perceptibly tinged green at its extremity. Fused with soda on charcoal, it afforded metallic lead and a brown slag. During this trial, I could perceive no odor of arsenic. The solution of the mineral in nitric acid, from which the lead had been removed by means of sulphuretted hydrogen, afforded a dense cloud on the addition of sulphuric acid mingled with alcohol, or of oxalate of potash; whilst by repeating the passage of sulphuretted hydrogen through the same liquid, only a slightly yellowish precipitate made its appearance, which consisted of sulphur. Hence the entire absence of arsenic acid was apparent. According to the mean of two analyses which were performed with three grammes of the mineral, I find its constituents to be,

Oxide of lead, - - - -	75.830
Muriatic acid, - - - -	2.110
Lime, - - - - -	3.711
Phosphoric and fluoric acids, trace of iron and loss,	18.349
	100.000

which gives the following composition:

Chloride of lead, - - -	10.642
Fluoride of calcium, - - -	0.248
Basic phosphate of lead, - -	81.651
——— lime, - - -	7.457
	99.998

3. *Crystallized Brown Lead Ore of Mies.*—The specimen employed in the following chemical examination, formed distinct prisms of

about one third of an inch in length and two lines in diameter, and of a clove-brown color. They were feebly translucent, and exhibited upon their sides perpendicular to the axis ($R - \infty$), a drusy surface. The true specific gravity of this mineral was 6.983. Pulverized and heated with sulphuric acid in a platina capsule, it occasioned a strong corrosion on a glass plate. Its behavior before the blowpipe was similar to that of the preceding variety. One hundred parts of the mineral contained,

Oxide of lead, - - - -	81.330
Muriatic acid, - - -	1.909
Lime, - - - - -	0.430
Phosphoric and fluoric acids, with loss,	16.331
	100.000

If we estimate these numbers agreeably to the formula employed above, taking as the basis of calculation the quantities of chlorine and oxide of lead found in the mineral, the crystallized Brown Lead Ore of Mies will consist of,

Chloride of lead, - - -	9.664
Fluoride of calcium, - -	0.219
Basic phosphate of lead, - -	89.263
———————— lime, - -	0.848
	99.999.

4. *Crystallized Brown Lead Ore of Bleistadt.*—This constitutes, as is well known, the most beautiful of the crystallized Brown Lead Ores, and occurs in perfectly transparent prisms of a clove-brown color. Prof. Breithaupt had the kindness to furnish me with very beautiful crystals for this examination. The specific gravity of this variety is 7.009. Before the blowpipe it decrepitates at first, but afterwards melts. The globule crystallizes during congelation. Melted with carbonate of soda it affords metallic lead, but offers no indications of arsenic. Heated with sulphuric acid, it corrodes glass. The solution of the mineral freed from lead by means of sulphuretted hydrogen, affords a precipitate on the addition of oxalate of potash, or of sulphuric acid diluted with alcohol. By a long continued stream of sulphuretted hydrogen, only a slight precipitate of sulphur appeared. One hundred parts of the mineral were composed of,

Oxide of lead, - - - - -	81.460
Muriatic acid, - - - -	1.956
Lime, - - - - -	0.320
Phosphoric and fluoric acids, and loss, -	16.264
	100.000

The constitution of this Brown Lead Ore, estimated by the preceding formula, and based upon the ascertained proportions of chlorine and oxide of lead, is as follows :

Chloride of lead, - - - -	9.918
Fluoride of calcium, - - -	0.137
Basic phosphate of lead, - - -	89.174
" " lime, - - -	0.771
	100.000

5. *Crystallized Brown Lead Ore from England.*—This Brown Lead Ore forms upon Galena, delicate needle-shaped crystals of a liver-brown color, which are perfectly transparent, and of an adamantine luster. I am not exactly informed of the precise locality of this variety : I purchased my specimens, furnished with the above ticket in German, last year at Lyons of a mineral-dealer, named Lafont. Before the blowpipe, it exhibits the same reactions as the varieties before enumerated. When treated with soda, no smell of arsenic was afforded ; neither did its solution tested in several ways afford any signs of the presence of this metal. Examined with sulphuric acid, I easily obtained though only in a feeble manner, signs of the presence of fluoric acid : in like manner also a very small proportion of lime was rendered obvious, by adding, after the separation of the lead, to the concentrated solution, sulphuric acid mingled with alcohol. The analysis of this ore could only be performed upon 0.9 grammes, which gave for the one hundred parts,

Oxide of lead, - - - - -	82.083
Muriatic acid, - - - -	1.990
Lime, - - - - -	0.320
Phosphoric and fluoric acids with loss,	15.607
	100.000

These results, estimated agreeably to the formula adopted above, and calculated upon the basis of the quantities of oxide of lead and muriatic acid ascertained in the analysis, give,

Chloride of lead, - - - -	10.074
Fluoride of calcium, - - -	0.130
Basic phosphate of lead, - - -	89.110
" " lime, - - -	0.682
	99.996

6. *Amorphous Brown Lead Ore from the Niclas mine, Freiberg.*—This variety of Brown Lead Ore, I owe to the politeness of Mr. Freiesleben, Counsellor of mines; it is described in his *Geological Researches* (Bd. 6. S. 147.) Its behavior before the blowpipe is similar to that of the varieties already described, and it exhibits no trace of arsenic. Heated with sulphuric acid in a platina capsule, it attacks with energy a glass plate held over the mixture. In a solution of it, in nitric acid from which the lead had been removed in the manner before described, sulphuric acid as well as oxalate of potash, produced a white precipitate. Nitrate of silver, added with suitable caution, occasioned a yellow precipitate. Therefore this Brown Lead Ore is constituted like those before examined, and contains lime and fluoric acid. The small quantity of the mineral at my command prevented me from undertaking its quantitive analysis.

7. *Crystallized Brown Lead Ore of Poullaouen (dep. Finesterre.)*—This variety of Brown Lead Ore which is the best known and characterized of the species, occurs in long, distinct prisms, often many lines in length, which are generally very irregular, and in which the regular terminations are not often distinguishable. This is more common than it is to observe a face perpendicular to the axis of the prism. The single crystals are for the most part furnished with an opaque, brown covering, which I have found to be composed of a mixture of phosphate of iron and phosphate of lead.

The specific gravity when pure, and in crystals freed from the coating alluded to, is according to Prof. Breithaupt, 7.0485.

Alone before the blowpipe, it melts into a polyhedral mass and at the same time feebly tinges the flame with a green color. If a fragment of it is treated with salt of phosphorus, a brisk effervescence takes place. With soda upon charcoal, metallic lead was obtained, but no evidence of the presence of arsenic.

Heated with sulphuric acid in a platina capsule, no extrication of fluoric acid fumes, nor any corrosion of a glass plate held over the capsule, was perceptible. No change was occasioned in the solution of the mineral freed from lead, although it was concentrated, either by the addition of sulphuric acid, or of oxalate of potash. Nor was any precipitate of sulphuret of arsenic produced by a stream of sulphuretted hydrogen passed through the solution. From these experiments, the entire absence of fluoric acid, arsenic acid and lime in this lead ore was clear; while it contains, as is sufficiently proved, only chlorine, lead and phosphoric acid.

According to two trials, in each of which four grammes of crystallized pieces were employed, previously freed from their ferruginous coatings, the Brown Lead Ore of Poullaouen contains in one hundred parts:

Oxide of lead, - - - - -	82.301
Muriatic acid, - - - -	1.989
Phosphoric acid with traces of iron and loss,	15.710
	100.000

or

1 atom chloride of lead = - - -	10.09
$3\frac{2}{3}$ atoms phosphate of lead = - -	89.91
	100.00

8. *Amorphous Brown Lead Ore of Poullaouen.*—In order to arrive at complete certainty respecting the absence of fluorine and calcium in the Brown Lead Ores of Poullaouen, and to establish upon as many data as possible a correct opinion of the chemical compositions of this mineral species, I have subjected still another variety from this celebrated locality, to analysis. The specimens examined, consisted of a compact, but superficially drusy mass, which in some spots exhibited a yellowish grey, in others, a hair-brown, color. Its specific gravity, I found to be 7.050. Before the blowpipe, it conducts exactly like the crystallized variety; also, it affords no odor of arsenic, when melted along with carbonate of soda. Heated in the state of powder with sulphuric acid in a platina capsule, it occasioned no corrosion to a glass plate held over its surface. Repeated researches, conducted in various ways upon its solution, afforded me no evidence of the presence of lime: by means of caustic ammonia only a slight precipitate of oxide of iron was thrown down.

One hundred parts of this mineral consist of:

Oxide of lead, - - - - - -	82.290
Muriatic acid, - - - - - -	1.989
Phosphoric acid with a trace of oxide of iron and loss,	15.721
	100.000
or	
1 atom chloride of lead = - - -	10.069
$3\frac{2}{3}$ atoms phosphate of lead = - -	89.931
	100.000

The following table is arranged to facilitate a review of the results concerning the chemical composition of the varieties of Brown Lead Ore herein examined.

Brown lead ore of	Sp. gravity.	Chloride of lead.	Fluoride of calcium.	$\frac{2}{3}$ Phosphate of lime.	$3\frac{2}{3}$ Phosphate of lead.	Oxide of iron.	Total.
Sonnenwirbel mine. (Polysphärite.)	6.092	10.838	1.094	11.053	77.015	—	100.000
Mies. (amorph.)	6.444	10.642	0.248	7.457	81.651	trace	99.998
Mies. (crystal.)	5.983	9.664	0.219	0.848	89.268	—	99.999
Bleistadt. do.	7.009	9.918	0.137	0.771	89.174	—	100.000
England. do.	—	10.074	0.130	0.682	89.110	—	99.996
Poullaouen. do.	7.048	10.090	—	—	89.910	trace	100.000
(do. amorph.)	7.050	10.069	—	—	89.931	trace	100.000

From the researches of Mr. Wöhler relating to four Phosphates and Arseniates of Lead it follows, as I have before remarked, that in the mineral Phosphates and Arseniates, a mixture in indefinite proportions, or a complete replacement of principles may happen, without giving rise to any variation in the crystalline form, or to the relative proportion of the lead in the basic salt, or to that in the chloride of lead. From the results of the analyses of the *seven* varieties of Brown Lead Ore, I think we can deduce the following conclusions.

1. The Brown Lead Ores are partly combinations of one atom chloride of lead and fluoride of calcium with three atoms and two thirds of phosphate of lead, and two thirds of phosphate of lime,—partly of one atom chloride of lead with three atoms and two thirds phosphate of lead, and correspond in the first case, to the formula,

$$\left.\begin{matrix} Pb\,Cl \\ Ca\,F \end{matrix}\right\} + 3 \left.\begin{matrix} \dot{P}b^3 \\ \dot{C}a^3 \end{matrix}\right\} \dddot{P}$$

in the second, to,

$$Pb\,Cl + 3\dot{P}b^3\,\dddot{P}\,.$$

2. In most of the Brown Lead Ores, a part of the lead is replaced by lime, and a part of the chlorine by fluorine. Hence the supposition made by Mr. *G. Rose* in his investigation of the Apatite, that it was not improbable that Green Lead Ores would be found, which should contain lime, is in reality confirmed.

3. The Brown Lead Ores are like the Green Lead Ores, isomorphous with Apatite, and constitute, if we may so speak, the connecting link between both species; which is not only true as respects their chemical composition, but as respects their specific gravity also, which is intermediate between the two.

4. The specific gravity is, in the six examined varieties, notably less than that of the Green Lead Ore; and sustains an inverse relation to the fluorine and calcium which they contain. The greater the quantity of fluorine and calcium in Brown Lead Ore, so much the less is the specific gravity, and the reverse.

5. It is obvious, that the existence of fluoric acid determines the presence of lime, or that the reverse takes place; since all the Brown Lead Ores examined by me, in which fluoric acid was found, contained also lime, and on the contrary, those which contained lime contained in like manner fluoric acid. This led me to regard the fluorine as united to the calcium, and conformably to this idea to conduct the calculation of the Brown Lead Ore,—considering that quantity of the calcium which remained after the saturation of the fluorine, as united with phosphoric acid.

6. None of the Brown Lead Ores analyzed, contain arsenic acid; and in them,

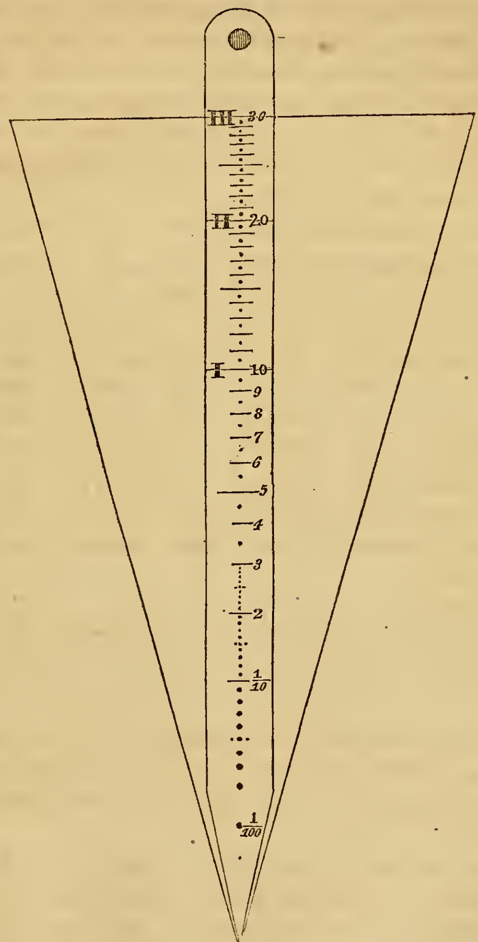
7. Chlorine is isomorphous with fluorine, and oxide of lead with lime.

The results of these researches may possess some interest in a chemical point of view, as well as affording a new example of the isomorphism of lime and oxide of lead; since, except the instance in which lime and lead are isomorphous in Arragonite and White Lead Ore, from whence *Mr. Mitscherlich* derived the fact, and which stood a long time as a solitary case, there were only three other examples known to me corroborative of the same thing; viz. the isomorphism of the sub-sulphate of lead and the sub-sulphate of lime, ascertained by *Mr. Heeren;* that of the Green Lead Ores and the Apatites proved by *Mr. G. Rose;* and that of the tungstate of lead and tungstate of lime observed by *Mr. Levy.* The present researches afford us a fourth example that lime and lead are isomorphous.

Art. X.—*Description of the Nine Inch Conical Rain Gage; by* S. DeWitt.

Read before the Albany Institute, May 3, 1832.

DeWitt's Nine Inch Conical Rain Gage, with the Scale represented in it.



Above 3 tenths of an inch, the scale is graduated to half tenths. The intermediate fractions may be measured with sufficient accuracy by the eye.

The contents of a cone nine inches high are equal to the contents of a cylinder three inches high, having its diameter equal to that of the base of the cone. Three inches fall of rain will then fill such a cone. Since the contents of similar cones are as the cube roots of their heights, in order to make a scale for measuring the rain fallen into such a cone, obtain the cube roots of 30 numbers, proceeding arithmetically from one, for the tenths of the three inches severally, and multiply each cube root by such a number as, being multiplied into the cube root of 30, shall give 9. That number is found to be 2.9. This will give 4.18, for three tenths of an inch; If then the 30 cube roots be multiplied by such a number as, when multiplied into the cube root of 30, will give 4.18, they will give the divisions of the scale for hundredths of the three first tenths of an inch. This multiplier is found to be 1.345, very nearly.

According to these rules the following table is constructed.

I.	II.	III.	IV.	I.	II.	III.	IV.
1	1.	2.90	1.345	16	2.521	7.30	3.39
2	1.260	3.65	1.69	17	2.571	7.45	3.46
3	1.442	4.18	1.94	18	2.621	7.60	3.53
4	1.587	4.60	2.13	19	2.668	7.74	3.59
5	1.710	4.96	2.30	20	2.714	7.87	3.65
6	1.817	5.27	2.44	21	2.759	8.	3.71
7	1.913	5.55	2.57	22	2.802	8.12	3.77
8	2.	5.80	2.69	23	2.844	8.24	3.83
9	2.080	6.03	2.80	24	2.885	8.36	3.88
10	2.154	6.25	2.90	25	2.924	8.48	3.93
11	2.224	6.45	3.	26	2.962	8.59	3.98
12	2.290	6.64	3.08	27	3.	8.70	4.03
13	2.352	6.82	3.16	28	3.036	8.80	4.08
14	2.410	6.99	3.24	29	3.072	8.90	4.13
15	2.467	7.15	3.32	30	3.107	9.	4.18

The first column contains the 30 numbers. The second, the cube roots of them. The third, their products multiplied by 2.9, for tenths of inches; and the fourth, their products multiplied by 1.345, for hundredths.

To measure the fall of rain in such a hollow cone, fixed with its base uppermost and horizontal, put down to its apex a stick of wood sharpened at its lower end, and mark the water-line on it; then the distance from that to the point of the stick, applied to a scale thus graduated, will show at once, in inches and decimals, the quantity of rain fallen; or the distance may be applied to a common scale of inches and decimals, and by comparing the length thus found, with the numbers in the third and fourth columns of the table, the same result will be shown.

A rain gage of this kind may be made of tin ware, painted and varnished, for less than half a dollar; and if observations made with it be repeated before the water rises high in it, they will be as accurate as those which are made with the rain gages commonly used, and costing twenty times as much.

The dimensions of the base of the cone may be taken at pleasure: five or six inches for its diameter may be considered advisable; but it is essential to the accuracy of the instrument that its height, measured perpendicularly from its inside apex to its base be exactly nine inches.

The conical rain gage, of which I gave a description to the Institute* sometime since, admits indefinitely of a scale of large divisions; but the cost of its construction is considerable. The scale of the one I have now described is limited in its graduation; but it is such as will serve, in a satisfactory manner and with as much accuracy as can be expected, the purpose of ascertaining the quantity of rain that may fall in the course of a year; and I hope that its cheapness, and easy acquisition, will induce many to possess themselves of it, and by its means, contribute to the observations instituted in our State on this important branch of Meteorology.

To persons whose minds have a turn to rational pursuits, observations of this kind would afford much gratification, even should curiosity alone be the prompter, but it would be heightened by the consciousness that thereby they might coöperate with others, intent on the promotion of useful science; besides, as a mere matter of amusement, this may be ranked among the rational and refined, which gentlemen of leisure might cultivate much to their pleasurable enjoyments, and, I may add, to their reputation as useful members of society.

To facilitate the making of a rain gage of this kind, I furnished a tinman with a pattern, which was a sector of 96° 22′ of a circle of 9.34 inches radius. The chord of this sector is 13.92 inches. This pattern, made of paper, having its side edges brought together, would form a cone exactly nine inches high, with a base of five inches diameter. In cutting out his sheet-tin by this pattern, he was directed to add just so much to the sides as was necessary for lapping, in soldering them to each other, and to add so much to the arch as was necessary for doubling, in order to stiffen the rim. By these directions he was enabled to make the cone as required, with accuracy, and at a trifling

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* Vol. I. No. 6. p. 60 of the Transactions.

expense. If the base of the cone be six inches in diameter the pattern will be a sector of 113° 50′, of a circle of 9.49 inches radius. The chord of this sector is 15.9 inches. The scale for this gage may be made by any person who understands the use of the common scale divided into inches and their decimals, by graduating a wooden rule, with a face of paper pasted on it, according to the numbers given in the table. The face ought to be varnished to protect it from the effects of the water adhering to the measuring stick.

The maximum of this gage is three inches, which exceeds the fall of rain from the heaviest shower. It must be a considerable rain that will produce one inch. The oftener the observations are made the more correct will be the account.

The following is a specimen of observations made with this gage.

		Inches.
1832, April	17	0.46
	18	0.90
	19	0.22
	20	0.13
	28 A. M.	0.47
	" P. M.	0.01
	30	0.50
May	1	0.06
	5	0.37
	9	0.24
	15	0.44
	19	0.32
	25 A. M.	0.47
	" P. M.	0.07

Art. XI.—*An account of several descents in a Diving Bell, at Portsmouth, N. H.; by the* Rev. Timothy Alden.

Communicated by Dr. Mease, with observations.

The curiosity and anxiety of people in Portsmouth, New Hampshire, were considerably excited, during the autumn of 1805, by an adventure, many times repeated, which, in that part of the United States, was the first of the kind ever attempted.

About two years, previously, a gondola, containing nearly twenty tons of bar iron, was accidentally sunk in the Piscataqua river, at the distance of thirty yards from Simes's wharf, where, at low water, there is a depth of sixty two feet.

Ebenezer Clifford, Esq. of Exeter, and Captain Richard Tripe, of Dover, formed a determination to attempt its recovery, and accordingly prepared a *diving bell*, five feet nine inches high, whose diameter, at the bottom, was five feet, and, at the top, three, in the clear. With the aid of this, it was their intention to get such hold of the gondola, as to suspend and bring it ashore. Seats were fixed for the accommodation of two men, and the shank of an old anchor, across the base of the diving bell, served as a resting place for their feet. A competent number of iron weights each 56 lbs. being properly secured on the rim of the base, so as to make the whole apparatus amount to nearly two tons, Clifford and Tripe descended to the bottom of the Piscataqua, the former six, and the latter ten or twelve times. Several others occasionally followed their example and the confidence of safety was, at length, so great, that some of the men, who assisted the adventurers, preferred going down in the diving bell to working at the windlass, by which it was lowered and hoisted. Two persons usually went together and they were, from sixty to seventy minutes, under water, twenty of which, at least, were taken up in the act of descending and returning.

The adventurers, several times, brought up a single bar of iron. In sweeping the bottom of the river, they also found a small anchor, of which they availed themselves.

Twice, with much difficulty, after a number of unsuccessful attempts, they made fast to the stem and stern of the gondola, and were on the point, as they had reason to suppose, of accomplishing the object of their submersion; but, twice were they frustrated by an unforeseen accident. Having made fast to the prize, it was, each time, expedient to defer weighing it till the succeeding day. Some kind of craft passing the place, by night, unfortunately, ran against the float, upon which was fixed their apparatus for managing the diving bell, and with which the hawsers, made fast to the sunken gondola, were connected, and thus blasted their hopes. By these disasters the gondola was so shattered, as to render it extremely difficult to get sufficient hold, a third time, to raise such a vast weight, and the enterprize was abandoned.

In descending, a painful sensation was induced on the tympanum, attended with a noise, as Mr. Clifford informed me, not unlike that of a fly entangled in a spider's web, till the adventurers were at the depth of about twelve feet, when, experiencing a sudden shock, they were completely relieved. This painful sensation, the shock, and subsequent relief, were regularly repeated, as nearly as could be judged, every twelve feet. After a few descents, it was perceived that, by being raised a foot or two, every eight or ten feet, the shock was avoided and the men were freed from that painful sensation, which had resulted from the uniformly increasing density of their atmosphere.

The adventurers once made their submarine descent, at the time of high water, when they were seventy two feet below the surface. Two thirds of the cavity of their vessel, as was imagined, without making any admeasurement, was then filled with water.

In a clear day and with an unruffled sea, they had light sufficient for reading a coarse print, at the greatest depth. As they moved the pebbles, with their gaff, at the bottom of the river, fish in abundance came to the place, like a flock of chickens, and as devoid of fear, as if it was a region, where they never had been molested by beings from the extra-aquatic world. From the description of the adventurers, no scenery in nature can be more beautiful, than that exhibited to them, in a sunshiny day, at the bottom of the deep Piscataqua.

It does not appear that the health of either of the men was in the least impaired, by their submarine excursions. Their pulsations, were quick, and their perspiration was very profuse, while under water; and, upon coming out of it, they felt themselves in a fit condition for a comfortable sleep.

One of my principal motives, for giving this account, is, to suggest a fact, which perhaps, is not unworthy of special notice. I offer it respectfully, without comment, hoping it will one day prove a hint to produce some experiments, which may be of importance in the *healing art.*

Mr. Clifford had, for many years, been afflicted with rheumatic pains. During the several weeks he was engaged in this enterprise, *he was remarkably free from this complaint.* The first time he descended in the diving bell, he happened to be considerably affected with his disorder; but, on coming out of it, he was entirely relieved from pain, insomuch that he walked, directly after, six miles, without inconvenience. This was an exertion, which he had not thought himself able to make, for several years before.

Could a series of experiments, be instituted, on proper subjects, who will venture to say, that the result would not be such, as to render a submarine descent, in a commodious diving bell, a frequent and favorite adventure?

Observations by Dr. Mease.

The painful sensation in the ear mentioned in the preceding paper, is invariably experienced by those who descend in diving bells; owing to the compression of the condensed air on the membrana tympani, but the means of preventing it, which were discovered by Messrs. Clifford and Tripe, are not mentioned in any of the accounts of diving which I have read, nor do the writers of them notice the "shock" felt by the Portsmouth divers which immediately preceded their relief from the pain. Dr. Hamel of St. Petersburgh states, that he was relieved of the pain by making exertions to admit air through the Eustachian tube into the ears, but, succeeded in accomplishing this at first, only on one side, when the air rushed into the cavity of the right ear, and the pain ceased instantly; when in the diving bell, he was not aware of the simple way in which it is effected. Dr. Wollaston informed him, that nothing is wanted but to swallow the saliva, as may be seen from the following simple experiment. Close your nostrils with the fingers, and suck, with the mouth shut: air will come through the Eustachian tube from the ear, and you feel pressure on the membrana tympani, which prevents you from hearing distinctly. As the end of the tube nearest to the mouth, acts like a valve, this sensation will often remain even after you have ceased sucking. To remove it, nothing is wanted but to swallow saliva, whereby the action of the muscles seems to open the end of the tube, and then the air rushes in to re-establish the equilibrium: during the descent of the bell Dr. Hamel says that the pain returned, but as he repeated his exertions to open the Eustachian tube, the air at intervals found a passage through it, and he obtained relief. Through the left Eustachian tube no air had yet passed and the pain in the left ear was gradually increasing, when about fourteen feet under water, the sensation was as if a stick was forced into the ear from without: at last, during one of the exertions to open the mouth of the tube on that side, the air forced its way in with considerable violence through it, and he was relieved from the pain also on that side. I presume the "shock" experienced by the Portsmouth divers, arose from the rushing of the air into and through the tubes, as it took place immediately preceding their obtaining relief from the pain in their ears. It may be useful to state, that this pain will be much diminished, if the bell be allowed to descend slowly, so as to admit the air gradually into the ear. In ascending, Dr. Hamel says the pain returned, resulting from the air in the inner cavity of the ear expanding, as the external pressure was diminished; but it was more easily relieved, the air gushing occasionally from the ear through the Eustachian tubes into the mouth.

Dr. H. suggests the probability of the diving bell being used with success for the cure of deafness in those cases where it depends on an obstruction of the Eustachian tube. The patient would have to go down in a diving bell, and make exertions to open the mouths of the Eustachian tubes, and then by the pressure of the condensed air, it would be forced through the extent of the tube, and thus clear the passage. He thinks that the fact of such slight obstructions having been frequently removed, by forcing air or tobacco smoke from the mouth into the ear, gives weight to the idea: but it is questionable whether the deaf person would be able to bear the great pain which it is reasonable to suppose he must endure from the condensation of the air on the tympanum, until the removal of the obstruction: and his sufferings might be so great as to deprive him temporarily of his presence of mind, and even of his senses. The experiment ought not therefore to be made, unless another person enjoying his hearing accompanied the patient. I have more well grounded confidence in syringing the ears with warm milk and water, to remove hardened wax. The relief experienced by Mr. Clifford from the rheumatism, after his diving, is well worth consideration by the faculty.

Dr. H. descended at Howth near Dublin, to make himself acquainted with the manner in which the diving bell for constructing the mason work under water is used; and says, that the bell was six feet long by four wide, and six feet high, with twelve patent glass-lights such as are used on a ship's deck, on the top. He was half an hour under water more than twenty feet deep, and had light enough to read and write. A constant supply of fresh air was given by means of a forcing pump, and the respiration was not in the least affected. A diving bell of the above dimensions may hold four persons. I mention these facts for the benefit of those who may have mason work to do under water. The writer of the article "diving bell" in the Edinburgh Encyclopædia of Dr. Brewster, republished in Philadelphia, by Joseph Parker, says, "the diving bell appears at first sight to be capable of very extensive use to engineers, in constructing the foundation of bridges, piers, sluices, and other works of hydraulic architecture. It would obviate the necessity of coffer-dams to inclose the area of the foundation, and of the engines for drawing out the water, preparations which are generally the occasion of greater labor and expense than the masonry or other work to be performed; and surveyors might have the means of examining the state of their work under water, or of making trifling repairs, which from the great difficulty at present of gaining access to the parts, are neglected and deferred, until they become of serious extent." He refers to the diving bell having been used on two important occasions by the eminent Smeaton: one was to repair some of the piers of the bridge over the Tyne, at Hexham, in Northumberland; and by it, he was enabled to fill the cavities beneath them with large rough stones. Another was for the purpose of getting up a quantity of large stones which some years before had been thrown into the sea at Ramsgate harbor, many of which were a ton in weight: one hundred tons were got up in the course of two months. Had a diving bell been used to examine the cause of the immense leakage of the western coffer-dam, when the first permanent bridge on the Schuylkill, at the west end of High-street, was in progress of erection in the year 1801, much time, labor and expense would have been saved. The cause of this is worth inserting.

When the British were in possession of Philadelphia in 1777, they constructed a bridge composed of pontoons, over the river, and two of the piles of the coffer-dam were obstructed by a part of one of those boats which had been accidentally sunk, twenty-eight feet below common low water. It occupied part of the area of the dam, with one end projecting under two of the piles of the inner row, and had nearly rendered the erection abortive, admitting the water which could not, for a long time, be overcome by all the pumps employed, until one was constructed by the ingenious George Clymer* of Philadelphia, which threw out 400 gallons per minute. The extra cost resulting from this unknown obstruction was $4000, and the labor required was performed in forty-one days and nights, in the midst of an inclement winter.†

Art. XII.—*On the Artificial Preparation of Cold Medicinal Waters; by* Wm. Meade, M. D.

Continued from Page 131.

The observations already made on the early methods of preparing cold medicinal waters render it unnecessary to go any farther into the subject; it has long been familiar to the scientific chemist, nor has its importance ever been doubted by those who know how nearly many of the common operations of nature, may be imitated by art.

A solution of any neutral salt in common water is not sufficient to constitute a true mineral or medicinal water; there is scarcely one of any value that is not impregnated more or less with carbonic acid gas, derived from some natural source. From the investigations of Dr. Black, we first learned that in their mild state, the alkalies contain a gas, by him called fixed air; which gas possesses acid properties; that it can be expelled from the mild alkalies, either by heat or by the stronger acids, and can then be combined with cold water to which it imparts peculiar properties.

The first attempt to apply this knowledge to medical purposes, seems to have been suggested some time after, by Dr. Hulme, who, without much chemical experience, proposed to saturate a solution of subcarbonate of potash with the gas already named. Being evolved by means of dilute sulphuric acid, the water acquired a lively pungent and sub-acid taste, and was then found to possess peculiar medicinal properties. This preparation which went by this name, came into general use for some time in cases of urinary calculi and other diseases of the bladder.

Some time after, lemon juice was substituted for the sulphuric acid, and this constitutes what is now called the saline effervescing draught,

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* Inventor of the powerful Columbian printing-press, the first iron press ever erected in the United States.

† See the interesting account by Judge Peters, of the erection of the bridge, attached to the first vol. of the Memoirs by the Philadelphia Soc. for promoting agriculture, for sale by McCarty and Davis, Philadelphia.

much used as a gentle refrigerant, aperient and diaphoretic. The nature of the acid of limes as well as of the other vegetable acids, was however at that period little known; it is from the celebrated *Scheele* that we have derived all our knowledge on this subject, as he first obtained the citric and tartaric acid in a crystallized state; as the crystallized citric acid possessed all the properties of lemon juice, it was soon substituted for it; it is recommended also by being cheap, imperishable and every where and always attainable. Scheele showed, moreover, that crystallized tartaric acid may be substituted for the citric, and it is still cheaper and more easily obtained.

Soon after this period, a preparation was made consisting of tartaric acid and super or bi-carbonate of soda; they are exhibited in separate powders in equivalent proportions; each is separately dissolved in water, and when the two solutions are mixed, rapid effervescence ensues, and the liberated carbonic acid gas imparts to the water the same pungent sub-acid taste, and stimulant properties, which the Seltzer and Piermont water is known to possess; while the alkali and acid form a neutral aperient and of course medicinal salt. This preparation under the name of soda powders is much used and not without reason, for it affords a most agreeable and salutary beverage. Besides being perfectly innocent, it is in the warm season much superior to most other liquids in allaying thirst, and being aperient and diaphoretic, it is usefully employed in slight febrile affections.

Soon after the introduction of these soda powders, another preparation was offered to the public, manufactured upon the same principle, under the name of Sedlitz powders, which when dissolved in water in a similar manner was described to constitute a perfect imitation of the mineral water of Sedlitz in Bohemia; but whatever medicinal effect these powders may produce, still the name is quite inappropriate, for the mineral waters of Sedlitz, do not contain a single substance in common with these powders. The Sedlitz water according to Bergman, and Hoffman, contains no carbonic acid gas, is neither brisk or acidulous, but is simply a saline mineral water, holding in solution no neutral salt except sulphate of magnesia, which gives it considerable cathartic qualities. The Sedlitz powders of commerce constitute an effervescent mixture which is highly pungent and acidulous and contain no other salt but the tartrate of soda, and of potassa, or what is denominated Rochelle salt, a peculiar neutral salt, with two bases, which has never been discovered in the Sedlitz, or any other mineral water whatever.

I would not imply that the Sedlitz powders are not medicinal; on the contrary, they are powerfully cathartic, and this mode of exhibiting the Rochelle salt is highly eligible. I object only to the substitution of this preparation for the mineral water of Sedlitz to which it has no resemblance, while at the same time, I quote it as an example of one of those methods by which an artificial preparation of a simple saline mineral water may be effectually imitated.

From this sketch of the different attempts which have been proposed to make an artificial preparation of cold medicinal waters, it will be seen that it was considered an object of importance from an early period, nor was it ever doubted either by the chemist or the physician, that water, when artificially prepared upon true scientific principles, possessed all the essential qualities of the natural spring, and the experience of the most eminent of the faculty has fully satisfied them of this fact.

The two different methods which have been proposed, possess their advantages as well as their disadvantages. That which was first adopted by Bergman, and which has been since improved as the knowledge of chemistry has advanced, is so correct in its principles, that it affords a perfect imitation of the natural water as proved by analysis; it may be said in a sense to bring the spring to every man's door, but the necessary apparatus is too expensive, and the process is too troublesome to admit of its being made in small quantities for domestic use. Nothing can be better adapted for large cities, but when it is bottled and sent to distant countries and different climates, it is obviously subjected to the same disadvantages as the natural waters. The heat of a warm climate will render the water perfectly vapid by the extrication of the gas, and the consequent precipitation of all those substances which it holds in solution; excessive cold will be equally effectual in injuring it; besides, not being a very portable article, the expense and inconvenience of carriage to any great distance renders it too expensive for most persons to purchase it. Under these circumstances, the discoveries of modern chemists into the nature and properties of the alkalies and their combination with carbonic acid gas, suggested to them the attempt of making an artificial preparation of the most celebrated mineral waters. By the superior affinity of other acids for the bases of the alkaline carbonates, the carbonic acid was expelled and combined with the water, while the stronger acid, with the alkali, formed a neutral salt, which enters into solution, and can only add to the medicinal qualities of the water.

This is the principle upon which is founded the extemporaneous method of impregnating cold water, at all seasons, with carbonic acid gas. As has been already stated, it imparts to the water the same sub-acid and pungent taste which it derives from the gas of the natural spring, and the neutral salt causes it to acquire mild medicinal properties.

It must now be perfectly obvious how every medicinal water may be effectually imitated as soon as the nature, properties, and proportions of those substances, and their mode of combination are ascertained by a previous chemical analysis. With the acid and alkaline powders prepared as above, an aqueous solution can be instantly produced so precisely similar in taste and in Medicinal qualities to the water intended to be imitated that no difference can be perceived; thus proving at the same time, by synthesis, the correctness of the previous analysis.

The advantages of these preparations are peculiarly great in this country. Mineral springs are distributed through every part of this vast continent, and its inhabitants are thus furnished with these important means of health in equal abundance as with the necessaries of life. Wherever these mineral waters are found, they are freely and advantageously used. As however the most valuable of these springs are not situated in those places where they are most required, many persons find great difficulty in having recourse to them at so great a distance from the fountain. I need only refer to the waters of Ballston and Saratoga, and especially to the Congress spring which is unrivalled and unequalled in medicinal qualities; but as these are more peculiarly adapted to a southern climate, frequent periodical journeys to these fountains, from such great distances, become not only inconvenient and expensive but for an invalid often impracticable.

Impressed therefore with the same view of the subject that has been expressed by Bergman and other chemists, it early occurred to me on visiting the springs for the purpose of making a chemical analysis of them, that an artificial preparation of the Congress spring may be effectually attempted, so as not only to produce the same taste, but, by combining all the substances which I had discovered in the Congress water, that a substitute for the natural water might be artificially prepared so as to render it equally beneficial to health, as the water of the spring, at seasons when it cannot be procured with convenience, and frequently not without the loss of a large portion of its useful properties.

Feeling, as many persons do on leaving the springs, a strong inclination to partake of the water, especially of the Congress spring, in a situation where I could not obtain it, I had recourse to the knowledge I had acquired of its contents from my previous analysis, and after performing some experiments on the subject, I succeeded in making such an imitation of it, as satisfied me that the preparation which I had made possessed all the essential qualities of the spring itself, that its taste was even more pungent and agreeable, and that when access could not be had to the spring, it may be used, medicinally, with nearly the same advantage. I continued not only to use it myself, when necessary, for several seasons, but distributed it to many of my acquaintance who were so well satisfied with its perfect imitation and the beneficial effects of it, that I was induced to offer it to the public in the year 1827. The method which I first pursued was to prepare two different powders containing those substances with which the mineral water at the spring was impregnated, in the proper proportions to make one tumbler of water, constituting an effervescing draught, upon the same principles as I have already described. The advantages of this method of making an imitation of the waters of any spring extemporaneously when the natural water could not be had in a state of purity, will appear obvious; these powders are portable and easily prepared, they could be taken in any country or climate, and made use of on a journey whenever they were required; not feeling, however, inclined at the time to commence the business of preparing them myself, I committed the preparation of these powders to other persons, from whom I received the most flattering accounts of their success; subsequently, however, I was informed that complaints had been made, that in many instances they were liable to deliquescence when kept for any time, and of course that their medicinal qualities were impaired, and the effervescence caused by a union of the different substances which constituted the powder was impaired.

Still, not willing to abandon my intention of imitating the Congress water effectually, and without the risk attending a deliquescence of the materials, I turned my attention again to the subject, and after repeated experiments, I succeeded not only in effectually counteracting any tendency to deliquescence in any climate, but also discovered a method of uniting the whole constituents of the spring in one powder, a spoonfull of which was sufficient at any time to make one glass of water so perfectly similar in all its properties to the water of the natural spring, that no difference could be observed between them.

This mode of making the artificial preparation which has never been adopted before, possesses the greatest advantage over every other by being kept in small bottles containing a sufficient quantity of the powder to make two dozen glasses of the artificial water; it thus becomes a cheap and portable article, capable of being taken to any distance without any inconvenience or injury, and without impairing any of its qualities. It is not my intention to enter further into the merits of this substitute for the water of the Congress mineral spring. Those of the Medical Faculty who have examined it, have expressed their unqualified approbation of this imitation of the natural water. To mention the names of those who have allowed me to do so, would be sufficient to stamp a value upon this preparation in this or any other country.

The public have now an opportunity of judging for themselves; that the effort will encounter prejudice from those who are either inerested or unacquainted with the nature of such a substitute must naturally be expected; many articles of the highest importance have encountered at first the most decided opposition before they have made their way against ignorance and prejudice: to me whatever may be thought of it, it is of little consequence whether this artificial preparation is received in the favorable light I intended it should be, but before I conclude, I beg that it may be perfectly understood that in offering this substitute for the natural water, and in pointing out its advantages, I have not the smallest view of representing it as possessing the same medicinal qualities as may be derived from the natural water, when drunk at the spring. In fact there are so many advantages connected with the use of it on the spot, where change of air, change of scenes, and agreeable society co-operate so much to the restoration of health, that few, who have it in their power, can hesitate in their choice. But on this subject I have expressed myself more fully in a separate treatise on the chemical analysis and medicinal qualities, of the Saratoga and Ballston waters; in this work I have fully expressed my agreement, in opinion with the most experienced physicians, who uniformly state, that in order to obtain the full benefit of any mineral water, it should be taken at the fountain.

Art. XIII.—*On the Malaria of the Campagna di Roma.*

Translated and communicated by Prof. Griscom.

At a period when so much is written, and felt of the prevalence of epidemic diseases, and while in the United States, there are many districts which are subject to the periodical visitation of epidemic fevers, and our own country as well as others, is liable throughout its whole extent to the formidable march of pestilence, and while philosophy is still so much baffled in its attempts to trace the intimate connection between meteoric and terrestrial influences, and the physiological changes of the human system, it is the part of wisdom to pursue the investigation, by a careful and industrious collection of facts. To the want of a sufficient acquaintance with the various phenomena attendant upon atmospheric changes, taken in connection with topographical peculiarities, and habits of life, must be attributed the darkness which still invests the various departments of pathological science. Knowledge, solid, practical and useful, makes but slow progress; but that it does make a progress, no one who compares the present state of chemistry, mechanics and astronomy, and the arts dependent upon them with their condition in the time of Lord Bacon, can hesitate for a moment to admit. The discovery of the circulation of the blood, of the constituent principles of atmospheric air, and of the nature of some of the changes which take place in respiration, together with the light which has been shed upon some other of the vital functions, must be regarded as important steps in inductive philosophy. These advances, together with the very extended knowledge of the composition and properties of matter which has been attained within the last half century, through the labors of Franklin, Black, Scheele, Priestley, Lavoisier, Davy and others, and the activity which at present prevails among men of science, encourage the belief that discoveries may yet be made which will lead to the detection of the real nature of the causes of Malaria, and elevate the dignity of medical philosophy by the application of remedies to this subtle and pervading poison. If the following essay SUR LE MALARIA DE LE CAMPAGNE DE ROME, taken from the *Bibliotheque Universelle,* of Geneva and constituting a portion of *Fragmens d'un voyage en Italie* (Morgenblatt, 1831) is deemed appropriate to the American Journal, its insertion is respectfully submitted.—G.

"Every body has heard of the bad air which exerts its pernicious influence in the latter part of summer, and which depopulates Rome and its environs. Among the writers who have turned their attention to this subject, the greater number are of opinion that Rome has not always been so unhealthy as it is at present, and they attribute the change to the superior cultivation of the soil which was practiced by the ancients. This opinion is not destitute of foundation; but it is valid, as may easily be conceived, only in relation to the time when Rome and the Campagna were in a very populous and flourishing condition. If we recede into times more remote and consider what the country must have been when first settled by those ancient inhabitants, we shall be obliged to admit that it must have contained extensive marshes and low grounds; we know that long after the foundation of Rome, there were considerable marshes between the different hills within its enclosure, especially between mounts Aventine and Palatine, and between the latter and the Capitoline. Dionysius of Halicarnassus informs us that they were very deep, and according to Propertius, they were crossed in sail boats. Livy compares the country of Rome at the time when the city was built, to a vast desert, and Ovid says that it was covered with frightful forests.

Experience teaches us that in all marshy and uncultivated countries, the air is unwholesome, and as we know how rapidly the population of Rome increased and to what a prodigious extent it arrived notwithstanding these unfavorable circumstances; how many towns of consequence such as Gabi and others, rose up in the vicinity of those pestilential lakes;—that Ostia even, founded by Ancus Martius, in a place where now, in the unhealthy season there is only a tavern supplying wine and bread to the herdsmen, formerly flourished, as well as Ardea, which at present contains only sixty inhabitants, and that Lavinium, is reduced to the miserable Chateau of Prattica, we are compelled to inquire how the ancients sheltered themselves from the pernicious influence of their unhealthy atmosphere.

Opinions on this subject are very various. Many learned men believe that the Champaigne of Latium was formerly less warm than at present: because according to Horace, the Soracte was covered with snow, and according to Livy the Tiber was sometimes frozen; whence they conclude that marshy exhalations were less active and pernicious. Others attribute the absence of disease in the midst of unwholesome air, to the more robust constitutions of the ancients, and say with Juvenal,

> Nam genus hoc vivo jam decrescebat Homero;
> Terra malos homines nunc educat atque pusillos.

Others again pretend that the air was purified by the great quantity of wood which existed within and without the city, because it is admitted that plants absorb carbonic acid, decompose it, and exhale oxygen gas. Although it may be true that plants exert such an influence, this theory cannot apply to the Campagna di Roma, for it would lead us to a result contrary to that which it is intended to establish. If the woods contributed in this manner to the purification of the air in the plain of Latium, they ought still to produce the same effect, since vegetation remains as vigorous as ever. On the contrary we find that the woody districts, such as the environs of Ardea, of Prattica, of Nettuno are the most unhealthy of all, and were so in the time of Tacitus. On this principle, the Villa Borghèse, the Villa Medici and others, which are not deficient in trees, ought to be more healthy than places which are deprived of them, which is not the case; in fact, the Vatican, like the Janicula, which are to a great extent covered with gardens and groves, are infected with the most unhealthy air. It results from all these facts that woods, in countries where from the physical constitution of the soil, malaria prevails, as in the Campagna di Roma, are injurious, because they check the winds which sweep away pestilential exhalations and renew the air.

Brocchi is of opinion, (and we think his views are correct,) that the chief protection of the ancient Romans consisted in their woolen garments, which kept their bodies in a state of constant transpiration. This opinion is justified by the observation that since the period at which the use of woolen clothing came again into vogue, intermittent fevers have very sensibly diminished at Rome. At present, even in the warmest weather, the shepherds clothe themselves in sheep skins, and it is surely for the purpose of protecting themselves against the bad air. The Toga of the Ancients, whose texture and shape were so well adapted to the body, has disappeared, and has been replaced, as Brocchi expresses it, by those garments of patch work, so flimsy, so ridiculous, and so unfit to guard those who wear them from the hurtful effects of an unhealthy atmosphere. It is worth while to ascertain whether the Monks, in their frocks, suffer less from bad air than the other inhabitants within and without Rome. Their great numbers would certainly incline one to believe in the propriety of such an inference.

The adoption of lighter clothing, on the one hand, and the neglect of good culture on the other, caused by the devastations which Rome and its suburbs have undergone, have given to the *Malaria* an energy which, by rendering the Campagna very sickly, has unpeopled the city to the extent which we now behold.

Before we terminate these considerations, we should say something of the diseases which at different epochs, visited the ancient Romans, and which they denominated plagues. Plutarch, Livy, Dionysius and others speak of those pestilential diseases which overtook the city of Rome under its kings and during the republic, and which must have occasioned a frightful mortality. But though we may not admit the term plague in its most rigorous sense; some of those diseases, which manifested themselves at distant intervals, came from Egypt by passing through Greece, as that in the year 573, and ravaged not only Latium, but the whole of Italy; other plagues mentioned by Livy were evidently *camp diseases*, as those of 287 and that of 365 when the Gauls beseiged the Capitol. In short, they might be other epidemic diseases which manifest themselves every where under certain conditions. But they were certainly not those intermittent fevers which now afflict Rome every year with greater or less severity.

From the preceding observations, we obtain the following result. The first inhabitants of Latium, who established themselves on the hills of that desert and marshy country, and who had to struggle against many obstacles in order to reduce the soil, were shielded against the unwholesome atmosphere by their woolen clothing which maintained a continual perspiration, whilst their assiduous and improved culture of the land, contributed to purify the atmosphere itself. But as this culture was again neglected on account of the numerous devastations which desolated Rome and the Campagna, the unhealthy exhalations of the soil were again multiplied, and the introduction of a lighter dress gave to this unhealthy air an influence which it had never before possessed. Brocchi relates that in 1818 there were admitted into the Hospital du St. Esprit, in the course of the months of July, August, and September, above 6000 patients attacked with fever by reason of the Malaria. The soldiers who occupied the forts on the borders of the sea, had to be relieved every three or four days, and nobody was willing to reap the harvest which covered the fields.

Opinions are very various with respect to the cause of this foul air. Some attribute it to exhalations of sulphuretted hydrogen,—others to those of carbonic acid gas; but as Brocchi observes those reasoners seem to have forgotten that all these gases are exhaled in abundance in different parts of Italy and Sicily which are nevertheless considered as very healthy.

The effect has also been imputed to exhalations of azotic gas; but this gas being lighter than atmospheric air would necessarily rise and thus render the heights more unhealthy than the vallies, while experience proves that the contrary is the fact.*

The Campagna of Rome is an extended country, cut up by little hills and mostly in an uncultivated state. During the rainy season, the water collects in the vallies and forms pools where it stagnates, and having brought with it all sorts of vegetable substances as well as animal refuse, it becomes corrupted. At the return of the warm season which augments the putrefaction, these ponds and marshes send forth their vapor, but as the process of evaporation goes on slowly, the heat being still moderate, the atmosphere is not much changed until the month of July brings with it a greatly increased temperature, which accelerates the evaporation, and which is accompanied by fevers whose duration equals its own; that is to say, it is prolonged to September.

If the Campagna were every where properly cultivated, as it was formerly, the air would not be subject to this alteration; for the rains of winter would not then collect as they do in the low grounds, but would be absorbed by a mellowed soil, and evaporated by the influence of the heat.

It must not be urged against this opinion, that in Lombardy, especially in the plains which extend from Bologna to Ferrara, the vast fields of Rice are, during the whole winter, covered with water, and that the country is nevertheless not unhealthy, or at least not so much so as that of Rome. These artificial lakes or inundations, as I have myself observed, are first, on account of their extent, always agitated by the wind, like a lake of water, and also by the action of the sluices by which they are supplied and drained, the current of water is continually entering and passing from them. These two causes combined prevent putrefaction.

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* While we admit, with the author that azotic gas is not the probable cause of epidemic fever, we must object to the soundness of his conclusion, with respect to its elevation. Although somewhat lighter than atmospheric air, it is, we believe most conformable to established facts in chemistry, to conclude that the particles of any gas, if set free in the atmosphere, will [ultimately] arrange themselves in the same manner as if the atmosphere itself did not exist, provided they have no affinity for, or do not combine with constituents of the air. Such is the Daltonian theory, which we believe has never been disproved.—*Trans.*

The learned Moscati thinks he has discovered that the basis of the foul air which causes these pestilential fevers, is an aqueous humor which contains an animal mucus in which the venom resides. Brocchi has made some experiments upon the nature of Malaria. He selected for this purpose the country which surrounds the basilica of St. Laurent, without the walls, one of the most unhealthy of Rome, and continued his labors during several successive nights. A robust young man, whom he took for his assistant, slept several hours during the first night, and was seized the following morning with an intermittent fever, which he retained for several weeks. Brocchi condensed, in various ways, the air which he had collected; and obtained in every case, a notable quantity of putrid water.

It remains for us to say a few words on the manner in which this foul air acts upon the animal organization. With respect to the mode by which it penetrates our bodies, Brocchi has several reasons for thinking that it penetrates rather by the pores of the skin than by respiration. When once the noxious particles are introduced into our organs they combine with the humors; the general organization, or more properly the force which tends to preserve it in its integrity, opposes this combination, and from this results the fever.

It is worthy of remark, that this foul air exerts no evil influence over the flocks which ramble night and day over the Campagna di Roma. This would seem to justify the idea that it penetrates by the pores of the skin, since these animals are defended by their hair or their wool, and hence we perceive a new proof that the best means which the ancient inhabitants of Latium, employed as a defense against this pernicious atmosphere, before an excellent state of cultivation had weakened its effects, was precisely the same kind of woolen clothing; so that the dress of the present age is very ill adapted to a country where an insalubrious atmosphere constantly prevails.

Art. XIV.—*On Central Forces; by* Prof. Theodore Strong.

(Continued from p. 135.)

Let the particle be acted upon by T as before, and by a force f, which is directed to the origin of r; also by a force f' which acts at right angles to r, in a plane passing through r at right angles to the fixed plane, this force tending to diminish θ. Then by resolving f, f' in the directions of r' and z, I have $f\cos.\theta$, $-f'\sin.\theta$ for the forces in the direction of r', and $f\sin.\theta, f'\cos.\theta$ for the forces in the direction of z. Hence the whole force in the direction of $r' = \text{P} = f\cos.\theta - f'\sin.\theta$; also the whole force in the direction of $z = \text{S} = f\sin.\theta + f'\cos.\theta$; but since $s = \tan.\theta \; \therefore \cos.\theta = \frac{1}{\sqrt{1+s^2}}$, $\sin.\theta = \frac{s}{\sqrt{1+s^2}}$, hence $\text{P} = \frac{1}{\sqrt{1+s^2}}(f - sf')$, $\text{S} = \frac{1}{\sqrt{1+s^2}}(sf + f')$. If Q is such a function that $-\frac{d\text{Q}}{dr} = f$, $-\frac{d\text{Q}}{rd\theta} = f'$, $\frac{d\text{Q}}{r'dv} = \text{T}$, then $\text{P} = \frac{1}{\sqrt{1+s^2}}\left(s\frac{d\text{Q}}{rd\theta} - \frac{d\text{Q}}{dr}\right)$, $\text{S} = -\frac{1}{\sqrt{1+s^2}}\left(\frac{d\text{Q}}{rd\theta} + s\frac{d\text{Q}}{dr}\right)$; but since $r\cos.\theta = r' = \frac{1}{u} \; \therefore r = \frac{1}{u\cos.\theta} = \frac{\sqrt{1+s^2}}{u}$, hence $\text{P} = \frac{1}{\sqrt{1+s^2}}\left(\frac{us}{\sqrt{1+s^2}}\frac{d\text{Q}}{d\theta} - \frac{d\text{Q}}{dr}\right)$, $\text{S} = -\frac{1}{\sqrt{1+s^2}} \cdot \left(\frac{u}{\sqrt{1+s^2}}\frac{d\text{Q}}{d\theta} + s\frac{d\text{Q}}{dr}\right)$; also $\text{T} = \frac{d\text{Q}}{r'dv} = u\frac{d\text{Q}}{dv}$. Now since Q is a function of r, v, θ, and as these are functions of u, v, s, $\therefore$ Q is a function of u, v, s; hence $\frac{d\text{Q}}{dr}dr + \frac{d\text{Q}}{dv}dv + \frac{d\text{Q}}{d\theta}d\theta = \frac{d\text{Q}}{du}du + \frac{d\text{Q}}{dv}dv + \frac{d\text{Q}}{ds}ds$, or $\frac{d\text{Q}}{dr}dr + \frac{d\text{Q}}{d\theta}d\theta = \frac{d\text{Q}}{du}du + \frac{d\text{Q}}{ds}ds$; but $u = \frac{\sqrt{1+s^2}}{r}$, $s = \tan.\theta$ give $du = \frac{sds}{r\sqrt{1+s^2}} - \frac{dr\sqrt{1+s^2}}{r^2} = usd\theta - \frac{u^2dr}{\sqrt{1+s^2}}$, $ds = \frac{d\theta}{\cos.^2\theta} = d\theta(1+s^2)$; by substituting these values of du, ds, there results $\frac{d\text{Q}}{dr}dr + \frac{d\text{Q}}{d\theta}d\theta = \frac{d\text{Q}}{du}\left(usd\theta - \frac{u^2dr}{\sqrt{1+s^2}}\right) + \frac{d\text{Q}}{ds}(1+s^2)d\theta$, which must be an identical equation; $\therefore$ by comparing the coefficients of $dr, d\theta$, I have $\frac{d\text{Q}}{dr} = -\frac{u^2}{\sqrt{1+s^2}}\frac{d\text{Q}}{du}$, $\frac{d\text{Q}}{d\theta} = us\frac{d\text{Q}}{du} + (1+s^2)\frac{d\text{Q}}{ds}$; hence $\text{P} = us\frac{d\text{Q}}{ds} + u^2\frac{d\text{Q}}{du}$,

$S=-u\frac{dQ}{ds}$, by substituting these values of P and S, and for T its value $u\frac{dQ}{dv}$, in (A), (B), (C) they become $dt=\frac{dv}{u^2\sqrt{h^2+2\int\left(\frac{dQ}{dv}\right).\frac{dv}{u^3}}}$,

(A′), $\frac{d^2u}{dv^2}+u+\frac{\left(\frac{dQ}{dv}\right).\frac{du}{u^2dv}-\left(\frac{dQ}{du}\right)-\frac{s}{u}.\left(\frac{dQ}{ds}\right)}{h^2+2\int\left(\frac{dQ}{dv}\right).\frac{dv}{u^2}}=0$, (B′), $\frac{d^2s}{dv^2}+s+\frac{\frac{ds}{dv}.\left(\frac{dQ}{dv}\right)-us.\left(\frac{dQ}{du}\right)-(1+s^2).\left(\frac{dQ}{ds}\right)}{u^2.\left(h^2+2\int\left(\frac{dQ}{dv}\right).\frac{dv}{u^2}\right)}=0$, (C′); which are the equations (K) given at p. 151, Vol. I. of the Mécanique Céleste.

(A′) is easily changed to $h^2+2\int\left(\frac{dQ}{dv}\right).\frac{dv}{u^2}-\frac{dv^2}{u^4dt^2}=0$, whose differential, regarding dv as constant, gives $\left(\frac{dQ}{dv}\right).\frac{dv}{u^2}+\frac{d^2tdv^2}{u^4dt^3}+\frac{2dv^2du}{u^5dt^2}=0$, $\therefore\frac{d^2t}{dv^2}+\frac{2dudt}{udv^2}+u^2\left(\frac{dQ}{dv}\right).\frac{dt^3}{dv^3}=0$; hence, and by reducing (B′), (C′) to a common denominator, rejecting the denominator and dividing by h^2 also dividing (C′) by u^2, there results $\frac{d^2t}{dv^2}+\frac{2dudt}{udv^2}+u^2\left(\frac{dQ}{dv}\right).\frac{dt^3}{dv^3}=0$, (A″), $\left(\frac{d^2u}{dv^2}+u\right).\left(1+\frac{2}{h^2}.\int\left(\frac{dQ}{dv}\right).\frac{dv}{u^2}\right)+\frac{1}{h^2}\left(\left(\frac{dQ}{dv}\right).\frac{du}{u^2dv}-\left(\frac{dQ}{du}\right)-\frac{s}{u}.\left(\frac{dQ}{ds}\right)\right)=0$, (B″), $\left(\frac{d^2s}{dv^2}+s\right).\left(1+\frac{2}{h^2}.\int\left(\frac{dQ}{dv}\right).\frac{dv}{u^2}\right)+\frac{1}{h^2u^2}.\left(\frac{ds}{dv}.\left(\frac{dQ}{dv}\right)-us.\left(\frac{dQ}{du}\right)-(1+s^2).\left(\frac{dQ}{ds}\right)\right)=0$, (C″), which agree with the equations (L) given at the place cited above.

Again, supposing the disturbing force to be situated in the plane of the curve described by the particle around the first centre; let s denote the length of the curve described in any time, $p=$ the perpendicular from the first centre to the tangent at the extremity of s, $\psi=$ the angle at which the radius vector (r) cuts s, $\frac{c'}{p}=V=\frac{ds}{dt}=$ the velocity, $\frac{pdr}{dp}=R=$ half the chord of the equicurve circle with s, at the place of the particle, estimating the chord on r. Then, since $c'dc' = \mathrm{T}r^3dv$, $\frac{dr}{rdv} = \cot.\psi$, (7) is easily changed to the forms

$$\frac{c'^2}{r^3} - \frac{c'^2 d\left(\frac{dr^2}{r^4dv^2}\right)}{2dr} - \frac{c'dc'dr}{r^4dv^2} = \frac{c'^2}{r^3} - \frac{c'^2 d\left(\frac{\cot.^2\psi}{r^2}\right)}{2dr} - \mathrm{T}\cot.\psi =$$

$$-\frac{c'^2}{2}\frac{d\left(\frac{1}{r^2\sin.^2\psi}\right)}{dr} - \mathrm{T}\cot.\psi = -\frac{c'^2}{2}\frac{d\left(\frac{1}{p^2}\right)}{dr} - \mathrm{T}\cot.\psi = \frac{c'^2dp}{p^3dr} - \mathrm{T}\cot.\psi$$

$$= \frac{\mathrm{V}^2dp}{pdr} - \mathrm{T}\cot.\psi = \frac{\mathrm{V}^2}{\mathrm{R}} - \mathrm{T}\cot.\psi = \frac{c'^2}{p^2\mathrm{R}} - \mathrm{T}\cot.\psi = \frac{c'^2}{r^2\mathrm{R}\sin.^2\psi} -$$

$$\mathrm{T}\cot.\psi = -\frac{d\left(\frac{c'^2}{r^2\sin.^2\psi}\right)}{2dr} + \frac{c'dc'}{r^2\sin.^2\psi\, dr} - \mathrm{T}\cot.\psi = -\frac{d\left(\frac{c'^2}{p^2}\right)}{2dr} +$$

$$\frac{\mathrm{T}}{\sin.\psi\cos.\psi} - \mathrm{T}\cot.\psi = -\frac{d\left(\frac{c'^2}{p^2}\right)}{2dr} + \mathrm{T}\tan.\psi = -\frac{d.\mathrm{V}^2}{2dr} + \frac{\mathrm{T}}{\sin.\psi\cos.\psi} -$$

$$\mathrm{T}\cot.\psi = -\frac{d.\mathrm{V}^2}{2dr} + \mathrm{T}\tan.\psi = \mathrm{F}, \text{ (D)}.$$

If the disturbing force acts constantly in the direction of the elements of s and is denoted by F', and if F'' denotes the attraction towards the first centre, then $\mathrm{F} = \mathrm{F}'' - \mathrm{F}'\cos.\psi$, $\mathrm{T} = \mathrm{F}'\sin.\psi$; by substituting these values of F and T in (D), since $-\mathrm{F}'\cos.\psi$ is found on both sides of the resulting equations, they become $\frac{c'^2}{r^3} -$

$$\frac{c'^2}{2}\frac{d\left(\frac{dr^2}{r^4dv^2}\right)}{dr} = \frac{c'^2}{r^3} - \frac{c'^2}{2}\frac{d\left(\frac{\cot.^2\psi}{r^2}\right)}{dr} = -\frac{c'^2}{2}\frac{d\left(\frac{1}{r^2\sin.^2\psi}\right)}{dr} = -\frac{c'^2}{2}\frac{d\left(\frac{1}{p^2}\right)}{dr}$$

$$= \frac{c'^2dp}{p^3dr} = \frac{\mathrm{V}^2dp}{pdr} = \frac{\mathrm{V}^2}{\mathrm{R}} = \frac{c'^2}{p^2\mathrm{R}} = \frac{c'^2}{r^2\mathrm{R}\sin.^2\psi} = -\frac{d\left(\frac{c'^2}{r^2\sin.^2\psi}\right)}{2dr} +$$

$$\frac{c'dc'}{r^2\sin.^2\psi\, dr} = -\frac{d\left(\frac{c'^2}{p^2}\right)}{2dr} + \frac{\mathrm{F}'}{\cos.\psi} = -\frac{d.\mathrm{V}^2}{2dr} + \frac{\mathrm{F}'}{\cos.\psi} = -\frac{d.\mathrm{V}^2}{2dr} + \frac{\mathrm{F}'ds}{dr}$$

$= \mathrm{F}''$, (E). It is evident that the formulæ (E) will apply whether the force F' is accelerating or retarding; for instance, they are applicable when the particle moves in a resisting medium, in which case the particle is retarded in the direction of the elements of s, and as F' is a retarding force its sign must be changed; also, the sign of $T=F'\sin.\psi$ must be changed, when c'^2 is calculated by (2). If the particle is supposed to describe a given curve around a given centre of force, and the expression for F'' is given, then the expression for F' is easily found by (E), for $-\frac{d.V^2}{2dr}-\frac{F'ds}{dr}=F''$, or $F'=-\frac{(2F''dr+d.V^2)}{2ds}$; also by (E) $\frac{V^2}{R}=F''$ ∴ $d.V^2=d(RF'')$, hence $F'=-\frac{(2F''dr+d(RF''))}{2ds}$, (F). Prin. B. II, prop. 17; Vince's Fluxions, prop. 43. If $F'=V^2h=F''Rh$, then $h=-\frac{(2F''dr+d(RF''))}{2F''Rds}$, (G), in which $h=$ the density of the medium; Prin. B. II, prop. 18.

If the centre of force is supposed to be removed to an infinite distance, so that r may be supposed to move parallel to itself, and if $F''=$ const. let x, z be the abscissa and ordinate of the curve, z being parallel to r and x perpendicular to it; let x and z have their origin at the highest point of the curve, then $dr=-dz$, $R=\frac{dx^2+dz^2}{d^2z}$; make dx constant, then $dR=\frac{2dz(d^2z)^2-ds^2d^3z}{(d^2z)^2}$; by substituting these values of dr, dR in (F), (G), they become $\frac{F'}{F''}=\frac{d^3zds}{2(d^2z)^2}$, (H), $h=\frac{d^3z}{2dsd^2z}$, (I). Prin. B. II, prop. 10; Méc. Cél. Vol. I, p. 26; also Vince's Fluxions, at the place cited above. It may be observed that (D) are applicable when the disturbing force is not in the plane of the curve described by the particle around the first centre, supposing r to be changed to r', F to P; that is, by supposing the particle and the forces which act upon it to be reduced orthographically to the fixed plane

Art. XV.—*On the elevation required for rails on Rail Roads of a given curvature; by* J. Thomson, Engineer, and late Professor of Mathematics in the University of Nashville, Tenn.

TO THE EDITOR.

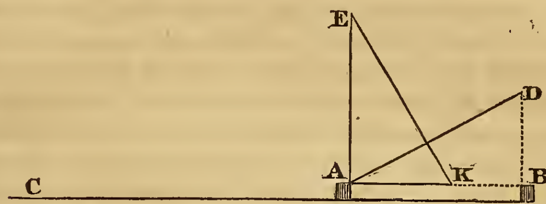
Sir—I observe, in a valuable little work on rail roads, by Col. Long, formerly Engineer in the service of the Baltimore and Ohio Rail Road Company, an article on the comparative elevation of rails, on the same track, when the rails are curved. The exterior rail requiring some elevation above the interior, when the road is curved, the question is to find what that difference of elevation ought to be, when the road has a given curvature and the carriage moves with a given velocity.

This question is investigated by Lieut. Dillahunty, who introduces into the investigation the centres of gravity and percussion; for what reason I cannot clearly perceive. When a loaded car moves along a rail road in a right line, the direction of the pressure of the load is perpendicular to the horizon; but when the car moves in a curved line, the direction of pressure is no longer vertical, but inclined towards the centre of motion. The object, therefore, of the investigation is to determine what elevation should be given to the exterior rail, so that the plane of the rails will be perpendicular to the direction of the pressure of the load. If this be (and it certainly ought to be) the object of the investigation, the results, as given by Lieut. Dillahunty, appear to be erroneous. These results are expressed by the two following formulas,

$$E=\frac{(R-r)^3}{2h(R+r)} \text{ and } E=\frac{2(R-r)^2V^2}{hW(R+r)}.$$

In these formulas, E represents the elevation of the exterior rail above the interior; R and r, the radii of the curves made by the rails; h the height of the centre of gravity of the load and carriage above the track; W the weight of the load and carriage, and V the velocity of the carriage. From the first formula it is evident (as observed by Lieut. D. himself,) that the elevation of the exterior rail will vary inversely as the height of the centre of gravity above the track, supposing R, r and V to be constant; and from the second formula, the elevation will vary inversely as the weight of the load and the height of the centre of gravity.

That these conclusions are erroneous, and that the elevation of the exterior rail does not depend on the weight of the load, nor on its height above the track, may be shown from the following considerations.



Let CAB represent a horizontal surface, on which a rail way is situated; A and B, the rails placed in a circular curve around C as a centre. A car in moving over the rails A and B, around the centre C, will be acted upon by two forces; one horizontal and centrifugal, arising from the motion of the car in a curved line, and acting in a direction from the centre C; the other, the force of gravity, acting in a vertical direction. I omit here, as not necessary in the present investigation, the moving force, derived from animal or other power, acting in the direction of a tangent to the curve. Let the horizontal line AK represent the centrifugal force above mentioned, and the line EA the force of gravity. It is evident that the resultant of these two forces will be EK, which will represent both the *intensity* and the *direction* of the pressure of the loaded car upon the rails. The line EK, therefore, representing the direction of pressure, the rails should be so placed that this line may be perpendicular to the plane passing through them. Draw the vertical line BD, and through A draw AD perpendicular to EK. BD will be the elevation of the exterior rail above the interior, and the angle DAB will be the inclination of the plane of the rails to the horizon. The centrifugal force AK, compared with the force of gravity AE, is easily found, when the radius of curvature of the track and the velocity of the car are given. The distance between the centre C and the middle of the track may be considered as the radius of curvature.

Now, by a reference to the above figure, it will be seen that a change of weight on the car cannot alter the elevation BD of the exterior rail, or the angle DAB. For, if we suppose the absolute weight of the load to increase or decrease, it is evident that the centrifugal force will increase or decrease in the same ratio—in other words, the lines AE and AK will vary in the same ratio, and hence the line EK will always remain parallel to itself, and perpendicular to AD, whatever be the weight of the load, other quantities remaining the same. Again the height of the center of gravity above the track cannot alter BD, or the angle DAB. For, if EK represent the direction of pressure of all parts of the load, it is evident that the center of gravity will tend in the same direction, in whatever part of the line EK it be situated, or whatever be its height above the track. It may be observed that the lines EA and AK, representing any given ratio, may be so drawn that the line EK may always be perpendicular on the middle of AD, in which case, the center of gravity of the load and car will always be situated in the line EK.

We may obtain a very simple algebraical expression for the elevation of the exterior rail. Let g = force of gravity, c = centrifugal force, d = distance between the rails, and E = required elevation, R and V representing radius and velocity. Then by the similar triangles EAK and ABD we have $E = \frac{cd}{g}$, but by central forces, $c = \frac{V^2}{R}$, hence $E = \frac{dV^2}{Rg}$. In this expression, g is always a constant quantity and equal to 32.2 feet.

To take an example, suppose a car to move with a velocity of twenty miles per hour, on a rail way, curving with a radius of four hundred feet, the distance between the rails being four feet nine inches. The velocity in this case will be twenty nine feet four inches. We then have $E = \frac{dV^2}{Rg} = 3.8$ inches. The table given by Col. Long makes the elevation in this case 5.5 inches, too much by nearly two inches. If we assume a radius of seven hundred and sixteen feet, the other quantities remaining the same, we find E = 2.1 inches. The above mentioned table makes the elevation three inches.

If the velocity of a car on a rail way were always the same, we should have no difficulty in assigning the proper elevation of the exterior rail. But as there must be necessarily a great variety in rates of traveling, an elevation which would be required by a rate of twenty miles per hour, would be much too great for a rate of eight, twelve or fifteen miles per hour. Perhaps the elevation required by the *mean velocity* would be the most eligible. There is one view of the subject however, which ought to be taken into consideration in the location of the exterior rail. When a car moves with great velocity on a curved road and the plain of the rails is horizontal, the flange of the fore wheel on the exterior rail is exposed to very great friction, which operates as a retarding force, and injures both the car and the rail way. This friction is diminished, though not altogether removed, by giving to the exterior rail, the elevation which the velocity and radius require. In order to reduce the friction still further, or remove it altogether, it would perhaps be advisable to increase by a small quantity the elevation obtained as above. It is evident that a car moving on the inclined plane AD, will tend by its own weight to approach A and recede from D. This will oppose the centrifugal force by which the flange is pressed against the rail D, and thus the friction will be in whole or in part removed. I know it has been maintained that the flange of the hind wheel on the *interior* rail produces as much friction as the flange of the exterior fore wheel. It may however be shown from various considerations, that if either of the hind wheels produces friction, it is rather the exterior one. Indeed we may suppose that motion is communicated to the hind wheels by a force which acts precisely in the same direction as if they were moved by animal power, the direction being nearly a tangent to the curve. This being admitted, the flanges of the two exterior wheels sustain all the friction occasioned by curvature. It may be observed however, that when the distance between the fore and hind wheels is comparatively very great, the direction of the force moving the hind wheels will vary considerably from the direction of a tangent, and consequently the friction will be diminished.

MISCELLANIES.

FOREIGN AND DOMESTIC.

Extracted and Translated by Prof. Griscom.

CHEMICAL AND MECHANICAL SCIENCE,

With practical applications.

1. Ilicine—*a remedy in intermittent fevers.*—Doct. Emile Rousseau has just published his own observations, together with those of eminent practitioners, in civil and marine hospitals, as well as those of various private physicians no less estimable, all uniting in ascribing to the leaves of the common Holly, (Ilex aquifolium) great efficacy in the treatment of intermittents. They consider this indi-

genous plant as the powerful succedaneum of quinquina and the sulphate of quinine. Several of them agree in considering the holly as superior to quinquina. Dr. Rousseau deserves great credit in bringing the virtues of this plant so fully into notice. He has succeeded in obtaining its active principle in an isolated form, and has given it the name of *Ilicine.*—*Rev. Encyc. Sept.* 1831.

2. *Fertilizing property of Sulphate of Lime.*—In order to determine the manner by which Plaster of Paris contributes to vegetable growth, M. Peschier, a pharmaceutist of Geneva, performed several comparative experiments. Two theories have been suggested by chemists—one, that the plaster acts simply as a stimulus to the organs of the plant—the other, that it gives up to the plants its water of crystallization. M. Peschier filled two vessels with siliceous sand slightly moistened, and sowed in each of them a few seeds of water cresses and watered one of them with pure water and the other with a solution of sulphate of lime. The plants, when a few inches high were burned, and equal quantities of their ashes were analyzed. In those watered with the solution of sulphate of lime, there was found a much more considerable quantity of sulphate of potash than in the other.

In a second experiment he found that the proportion of sulphate of potash was increased when the plants watered with the solution of sulphate of lime, were subjected to the action of a galvanic current.

M. Peschier thence infers that the plaster undergoes a decomposition by the act of vegetation, and he thinks he has observed that crude plaster is more efficacious than that which has *been calcined. Rev. Encyc. Nov.* 1831.

3. *Composition of Gum.*—M. Guerin read to the French Academy a memoir on Gum, in which he maintains, that no substance is a gum but that which, when treated with nitric acid, produces mucic acid. He shows that this property depends on two immediate principles, one of which is always present in gum and more frequently both together, though in very unequal proportions. One of these principles is *arabine*, the soluble portion; the other *bassorine*, insoluble. He divides all gums into two great families dependent on the predominance of one or the other of these principles. The memoir contains an analysis of the different gums, showing the proportion of these elements in each.—*Idem.*

4. *Hydruret of Sulphur.*—M. Thenard read to the French academy, on the 28th of November last, a memoir on hydrogenated sulphur or hydruret of sulphur. This substance was first observed by Scheele, who obtained it by pouring hydro-sulphuret of potash, into an excess of diluted hydrochloric acid. It is in the form of a yellowish liquid of an oily consistence, and an unpleasant odor. Scheele and Berthollet determined that it is heavier than water, and insoluble in that liquid, that it undergoes spontaneous decomposition at common temperatures, and that acids of moderate strength, far from destroying it, give it consistence.

M. Thenard, in subjecting it to a new examination, has discovered in it the following properties; applied to the tongue, it produces the same effect as the binoxide of hydrogen, viz. to whiten it and produce a painful blister. It spread over the skin, it discolors and injures it. It readily destroys the color of tournsol. It is of variable consistence, sometimes like that of common oil, and at others like an essential oil, depending apparently upon the relative quantities of sulphur and hydrogen which it contains. Its density probably changes from a similar cause. In one case in which its fluidity was imperfect, it was found to be equal to 1.769.

The hydruret of sulphur does not congeal at a cold of 20° (Cent.) The heat of boiling water promptly decomposes it, the liquid being transformed into sulphuretted hydrogen gas, which flies off, and leaves a residuum of sulphur. When left to itself, it undergoes a gradual change. If pure, the residuum is nothing but sulphur, which is at first soft, but at length becomes solid.

The air has no action upon it in ordinary circumstances, but on the approach of a lighted taper, it inflames, the hydrogen forms water, and the sulphur, sulphurous acid.

Charcoal, in fine powder, occasions a rapid disengagement of sulphuretted hydrogen.

Platinum, gold, iridium, and several other metals in powder, produce a similar effect. Various oxides, in powder, have the same property, being attended with a strong effervescence. Such are the effects of peroxide of manganese, baryta, magnesia, strontia, lime, potash and soda. The two latter have the remarkable property of producing the same phenomenon when in a state of solution.

Oxides which part readily with their oxygen, are instantly reduced by the hydruret of sulphur, with the production of water and with incandescence.

The sulphurets tend also to decompose it. In powder or in solution the alkaline sulphurets produce a disengagement of gas and a precipitation of sulphur.

Sugar, starch, fibrine, and muscular flesh, act upon it slowly, but animal matters more sensibly than vegetable.

Ether dissolves the liquid, immediately, but soon deposits needle-form crystals which appear to be pure sulphur.

In all the cases above recited, there will be perceived, in the action of other bodies, a remarkable analogy with the binoxide of hydrogen of M. Thenard.

Other compounds will probably in time be discovered, having analogous properties, and thus establish a new branch of chemistry. *Rev. Encyc. Nov.* 1831.

5. *Chemical Agency of Light.*—A series of experiments on the relations of oxalic acid to metallic oxides, conducted by J. W. Döbereiner, induces him to draw the inference that the chemical influence of light is very rarely analogous to that of heat, and that it is *sui generis;*—that the one determines a contraction, the other an expansion, of the matter, and that the reductive action of light is a consequence of the contractive force of that agent, while the effect by which heat promotes combustion and almost every kind of chemical penetration, is the result of the dilatation of the matter occasioned by it. The cause of this opposition of effect is unknown, and we can scarcely hope to discover it, when we reflect with what facility light is transformed into heat, and *vice versa.*—*Bib. Univ. Nov.* 1831.

6. *Splendid combustion of hydrogen gas under strong compression;* by Prof. Döbereiner. (Jahrbuch für Chemie und Physik.)—Hydrogen gas, under common pressure, burns, both in atmospheric air and oxygen gas, with a feeble and scarcely visible flame. The flame becomes more brilliant only when brought into contact with a more solid substance, susceptible of becoming red hot, such as platinum foil, oxide of zinc, lime, magnesia, &c.

Davy infers from phenomena of this sort, that the brilliancy of all flame is owing to the presence of a solid incandescent substance, which is formed or disengaged during combustion, and that a gaseous substance never can be heated so as to emit a vivid light.

The cause of these opposite phenomena, may be found in the different modes by which heat acts on various substances; elastic fluids and volatile substances expand by caloric and disperse it, while solid bodies resist the repulsive action, and absorb and condense the heat so as to become luminous.

But if this view be correct, gaseous substances, disengaged by combustion, ought, when forcibly restrained from expansion, to exhibit incandescence and splendor.

An experiment, at once simple and brilliant, confirms the justness of this conclusion.

If a mixture of two volumes of hydrogen and one of oxygen be confined in a strong globe of one or two cubic inches in capacity, *perfectly* dry internally, and well closed, and then kindled, it burns with as brilliant a light as that of phosphorus in oxygen gas. If the detonating gas be compressed into the globe by two atmospheres, it emits, when kindled, the splendor of lightning. Even in open day, its effect is like that of the most vivid lightning; and by night, it is so much like a burst of sun shine, that oyster shells, heated with sulphur, become phosphorescent when exposed to it. If there be moisture in the globe, or if the cock be left open, the light is very feeble, because in the first case the light is absorbed by the moisture, and in the second, dispersed by the sudden expansion.

The kindling of the explosive mixture is best effected by the electric spark, and the author recommends the apparatus described in Singer's Elements of Electricity, p. 126, fig. 30. The wires of such an apparatus should approach the nearer as the gas is more compressed, for the spark in condensed gases will not pass through so great a space.

These facts induce the author to seek for the cause and condition of the brilliancy of flame, not in the presence of solid, incandescent matter, but in the forcible accumulation or condensation of caloric, and he thinks it not hazarding too much to propose this point of view as a photological axiom. He has not examined the luminous effect of burning, in this manner, gases, which by combustion with oxygen, give permanently elastic products. It is rare to find globes of glass strong enough, and of uniform resistance. Tubes are not suitable, as they present too large a surface, and consequently absorb too much heat.—*Idem.*

7. *Protoxide of Copper.* (Wöhler and Liebig.)—The most simple and easy method of obtaining protoxide of copper is the following. Dissolve the copper in hydrochloric acid, to which small por-

tions of nitric acid are by degrees to be added,—then evaporate to dryness, and heat the resulting chloride to the melting point. It is thus transformed into a brown crystalline chloruret. Ten parts of this are to be mixed with six parts of anhydrous carbonate of soda, and heated in a covered crucible to dull redness. Treat the mass with water in order to dissolve the marine salt that will be formed,—the protoxide of copper separates in a beautiful red powder, not crystalline, which is to be washed and dried.

If sal ammoniac is added to the above mixture, the whole of the chloruret is reduced, as might easily be foreseen, and the metallic copper separates in a minutely divided, spongiform mass, on the addition of water.—*Ann. de Chimie, Juillet*, 1831.

8. *Estimation of the bleaching power of chloride of lime.*—M. Marozeau proposes to employ the protochloride of mercury for this purpose. Being insoluble in water, and even in hydrochloric acid, it becomes by the addition of chlorine changed to the deutochloride, and is then immediately soluble.

His method is this,—take a solution of protonitrate of mercury, add a more than sufficient quantity of hydrochloric acid to precipitate all the mercury in the state of protochloride, pour into the liquid a solution of the chloride of lime—the chlorine, set free, acts on the precipitate, which gradually diminishes, and the process is to be stopped at the moment when a drop of the chloride of lime completes the entire solution. The quantity of the chloride of lime, used for a fixed quantity of the test liquid, indicates the strength of the chlorides. The author has formed a table which agrees with that of Gay Lussac.—*Idem, Avril*, 1831.

9. *Inflammation of gunpowder under water.*—In the port of Penemund, (says Prof. Hünefeld of Greifswalde,) there was situated an enormous rock, covered with water about three feet, which was a serious impediment to the navigation. Efforts had been made, but in vain, to remove it, by mechanical force, and it was not known by what means it could be blasted. The difficulty was at length overcome by Engineer Lübke.

A leaden tube, several feet long and closed at the lower end, was inserted into a hole, bored several years before, in the rock. A cartridge was pushed to the bottom, and in contact with the powder over it, a little piece of potassium. The upper part of the tube was funnel shaped, and contained a thimble shaped vessel filled with water, and supported in an upright position by a piece of amadou, which, by a simple arrangement, would, when burnt, allow the thimble to overturn. The amadou being set on fire, the workman rowed off to a safe distance and waited the event. The thimble being overturned, the water inflamed the potassium and the latter the powder, and the explosion succeeded well. A second trial was equally favorable. The powder must be very dry, otherwise potassium will not inflame it; common gunpowder is generally too damp.—*Bib. Univ. Aout*, 1831.

10. *Cause of Goitre.*—M. de Humboldt communicated to the French Academy, in October, 1831, some results obtained by Boussingault, in his researches into the causes of Goitre, in Colombia. The latter ascertained that in every place in which Goitre is very common, the water holds in solution only a very small quantity of air. It is well known that the production of Goitre is very often attributed to snow water. This agrees very well with the discovery of Boussingault, since water, in freezing, abandons a great part of the air which it held in solution, so that when melted it is almost wholly free from air.—*Rev. Encyc. Oct.* 1831.

11. *Memoir on the transference of ponderable substances by electricity.* (Dr. A. Fusinieri.)—This paper contains the result of numerous experiments and observations made for the purpose of ascertaining whether the electric spark carries with it any portion of the material from which it issues.

Dr. F. finds that when the spark issues from metallic conductors whatever may be the nature of the metal, one portion of it is carried away in a state of fusion and another in incandescent molecules, and that when the conductor is a compound metal, as of brass, a portion of zinc is separated from the copper. The metal thus dispersed, is spread in extremely thin laminæ, over the surface on which the electric current falls, where its presence may be detected by changes of color, and other tests. The substance thus conveyed will even penetrate in its passage through thin plates of metal; small portions being left behind upon the plate while the rest passes along, with the spark, to the surface on which it strikes.

These metallic spots derived from the electric spark are so thin, that after a certain time they are volatilized and disappear.

But another interesting fact is, that when the spark issues from one metallic surface and falls upon another, there is a reciprocal transfer in opposite currents of each metal to the other. Thus if the spark issues from silver and falls upon copper, there is not only a transfer of the silver to the copper but also of the copper to the silver. If the spark passes from gold to silver, there is a transfer of the silver to the gold as of the gold to the silver.

There are thus produced by the electric current two forcible and contrary percussions, occasioned by the metal which has been transferred; the one, at the point from which it is detached, the other at that where it enters into the other metal; the existence of these two percussions, is shown by the presence of two opposite cavities which contain the same metal in a state which proves it to have undergone a fusion; hence the metal which passes exerts two pressures in contrary directions.

The electric current in passing from one metal to another, leaves the first in the second, and takes a small quantity of the latter.

The electric spark, which issues from a metal and passes into the air, contains a group of molecules, the central portions of which are in a state of simple fusion and the exterior portions undergo a combustion more or less vivid, by their contact with the oxygen, according to the greater or less oxydizable nature of the metal.

The electric sparks between the two poles of a voltaic pile, terminated either by metals or charcoal, contain also particles of these substances, in a state of extreme division and of combustion; the ignition of metallic leaves is only an extended scintillation repeated from place to place in these leaves, which on account of their extreme tenuity, may be regarded as discontinuous.

From the foregoing facts, the author infers;

That the electric spark of our machines is not a distinct imponderable fluid as is generally supposed;—and that the heat and light proceed from the ignition and combustion of the particles of ponderable matter.*

The author has examined the tracks of the electric current in trees, buildings, &c., which have been struck by lightning, and finds what he deems to be certain evidences of the transfer of pondera-

* This reasoning appears to be unphilosophical, inasmuch as ignition always presupposes an increase of heat, and therefore to ascribe the heat to ignition, is to confound the effect with the cause.—*Tr.*

ble matter, beside the odor which often accompanies these phenomena.—*Bib. Univ. Decem.* 1831.

12. *Stature of the Human Race.* Isidore Geoffroy Saint Hilaire.—Contrary to what occurs among domestic animals, variations of stature in the human race are included in much narrower limits than individual variations.

The size of women is less variable than that of men. They are much smaller than men among people of large stature, while the difference in size between the sexes is very small among people of low stature.

The people who are the most remarkable for their great height, generally inhabit the southern hemisphere; and, as has long been known, those who are distinguished for lowness of stature almost all reside in the northern hemisphere.

Among the people of the greatest height some live on the southern part of the American continents, others, in various archipelagos of the Southern Ocean, and it may even be remarked that they thus form in the southern hemisphere two series, one continental, the other insular, both irregular and often interrupted, but commencing in each, at eight or ten degrees of south latitude and terminating at about fifty degrees.

There exist however, in the southern hemisphere, people whose height is below the mean, and reciprocally, in the northern, those whose height surpasses the mean. Now, in comparing the geographical position of these people with those who are extremely tall or extremely short, we arrive at the result apparently paradoxical, and yet in part of easy explanation, that the short race live almost every where near the tallest nations, and reciprocally, the tallest people near those nations who are the most remarkable for their low stature.

The diversity of stature in the human race may be explained, (but in part only) by the influence of climate, of dietetic regimen and mode of life.

It is at least extremely probable that the size of the race, notwithstanding some local variations, has not sensibly diminished; and this, not only, from the concurrence of so many kinds of proof as are derivable from historical evidence from the earliest known periods; but from considerations of science, in the absence of all monuments, it may be inferred that there has been no material change since the origin of mankind.—*Rev. Ency. Jan.*

13. *New Machine.*—At the meeting of the French Academy held Jan. 9th, 1832, M. Cagniard Latour gave a description of a new machine of his invention which he calls a *hydraulic volcano.* The principal piece consists of a bundle of tubes, of a calibre so small that the liquids and gas which are simultaneously introduced may remain mixed during their circulation, and form an intermittent column analogous to that of several machines already known, such as the pump of Seville, the fountain of circulation, and the mercurial pneumatic screw of Cagniard which is described in a report made in 1809 to the Academy by Carnot.

The water of a reservoir may be raised in a very simple manner by this machine, provided there is at hand a very small current of air nearly insoluble in water, for example a current of compressed atmospheric air. The lower part of the capillary stock is to be depressed to a certain depth in the water, and under this the gaseous current is to be introduced, by means of a tube conveniently adjusted. A mixed column of air and water immediately rises in each tube, which, if the proportion of gas is large enough, is lighter than the column of the reservoir which presses it upwards. Hence there is a constant ascensional movement, and from the top of each tube there will be a flow of air mixed with water.—*Idem.*

At a subsequent meeting of the Academy, *M. Sarrut*, professor of science at Strasburgh, announced that in the course of physique which he had given at Perpignan from 1827 to 1830 he had described an apparatus similar to that of Cagniard. It had been applied to mesh tubs in such a manner as to raise again to the top the ley which flows from an inferior opening, and spread it over the linen. Instead of a current of air, a stream of vapor was used from a small vessel of boiling water, which communicated with the ascending canal by a bent tube.

14. *Large Achromatic Telescopes of M. Cauchoix.*—M. Cauchoix, a distinguished optician of Paris, having sold a year or two since to Sir James South, an instrument with an object glass of eleven inches (french) aperture, and for which a gold prize medal was adjudged at the exhibition of the Louvre of 1823, has just delivered

to Edw. Cooper, M. P. an instrument of twelve and a half inches aperture. These are the two largest achromatics which exist. The first already proved by a great number of Astronomers, appears to be an excellent instrument, and M. Cauchoix hopes that the other will not be less satisfactory. He has just finished a new telescope, similar to Mr. South's, whose aperture is eleven inches fr. and focal distance eighteen feet. The effect of this instrument appears still better, the images more neat, the materials exempt from all threads and striæ. He has also ready for delivery an excellent instrument of eight and a quarter inches diameter, and twelve feet focus, and he also has object glasses of seven and a half, seven, six and a half, six, &c. The flint glass of all these object glasses is we believe of the manufacture of M. Guinand.

M. Cauchoix has constructed object glasses in which the crown glass is replaced by rock crystal, and which have the advantage of greater amplifying power, joined to a less focal distance. He possesses three of fifty nine lines diameter, and fifty inches focal distance, and he thinks, from the difficulty he has found for the last four years in procuring disks of this diameter, of sufficient purity, that others of these dimensions can scarcely be obtained.

On account of ill health, M. Cauchoix, is about to relinquish his establishment, to his nephew, who unites much solid information to the experience derived from his uncle..—*Bib. Univ. Sep.* 1831.

15. *Preservation of plants during winter by spring water.*—A horticulturist in Scotland has availed himself of the heat of spring water, in the preservation of delicate plants. He places boxes of pine wood over the water, covering them with some coarse stuff, and in these boxes he places pots of cauliflowers, lettuce, various sorts of pelargoniums, Indian chrysanthemums, Chinese primroses, &c. and by this simple and economical method, preserves them all winter. He is of opinion that by means of the temperature of running water, winter gardens may be constructed for a farm or village. Care must be taken to renew the air in the boxes.—*Idem.*

16. *French premiums.*—The following prizes are offered by the French Society for the Encouragement of National Industry, one half of the funds being furnished by the minister of trade and public works.

For 1832.

	Francs.
Hackling of flax by machinery, - - -	12,000
Application in shops and manufactories of the curved pallet wheel of Bélidor, - - - - -	6,000
Fabrication of water pipes, of iron, wood or stone, five premiums—together - - - - -	13,500
Application of the rail road system to the irregular levels of common roads, - - - - -	3,000
Making of bricks and tiles by machinery, - -	2,000
Means of safety in steam engines and boilers for vaporization, each - - - - - -	12,000
Construction of a hand mill for hulling dry beans, peas, &c.	1,000
Fabrication of bottles for holding fermenting wine, -	3,000
Best substitute for the rotting of hemp and flax, -	6,000
Preparation of metallic gauze or armor, and of amianthine cloth, as a defense against flame and for a process for rendering organic tissues incombustible, three premiums—together, - - - - - -	4,200
Perfection of iron founderies, - - - -	6,000
Perfecting the construction of furnaces, three premiums—together, - - - - - -	9,000
Fabrication, on a large scale, of refractory crucibles, -	3,000
Perfection of lithography, four questions, - -	3,500
Lithographic impressions in color, - - -	2,000
Manufacture of fish glue, - - - -	2,000
Silvering looking glasses by a process different from that in common use, - - - - -	2,400
Discovery of a metal or alloy, less oxidable than iron and steel, suitable for instruments for dividing soft alimentary substances, - - - - -	3,000
Cleaning of barks, fit for the fabrication of paper, -	1,200
Making of vessels suitable for the preservation, during several years, of alimentary substances, - -	3,000
Preservation of ice, - - - - -	2,000
Plantation of paper mulberry, - - -	1,500
Cultivation of Northern and Scotch pine, - -	2,000
Detailed description of the best kinds of domestic manufacturing industry, suitable for the inhabitants of the country, } 1st pr.	3,000
2d "	1,500

Construction of an instrument for cleaning buckwheat,		600
Introduction into France, and the culture of plants useful to agriculture, manufactures and arts,	1st pr.	2,000
	2d "	1,000

For the year 1833.

Discovery and working of quarries of lithographic stones,		3,000
Artificial stones for lithography,		2,000
Transfer of old engravings to lithographic stones,		1,000
Method of giving to starch the property of rising like wheat flour,		6,000
Method of detecting the mixture of starch with wheat flour,		2,400
For the drying of meat,		5,000
Plantation of slopes, (terrains en pente,)	1st pr.	5,000
	2d "	1,500

For the year 1834.

Fabrication of sewing needles,		3,000
Description of the process of bleaching cloth destined for printing, preparation of colors, their application, and of machines used in these different processes,		5,000
Manufacture of Chinese paper,		2,000
Beet sugar establishments, a rural occupation,	1st pr.	4,000
	2d "	1,500

For the year 1835.

Determination of the effect of lime in fertilizing land,		1,500
Total,		164,300

Bull. d'Encour.

17. *Influence of heat on magnetism*, by Ch. Matteuci.—It results from the experiments of the author on this subject:

1. That cold increases magnetic intensity, and that heat diminishes it.

2. Within the limits of temperature to which the apparatus was exposed, the changes are equal, for an equal number of degrees.

3. The magnetic intensity, and the physical constitution of the body, are the principal elements of the phenomenon.

4. Within the same limits, the changes in question are only temporary.

5. The cooling of non-magnetic iron develops magnetism, or rather makes it more easy to be magnetised.

Among the experiments from which these inferences were drawn, were the following. A needle, properly suspended, made sixty six oscillations in 60″, by the force of terrestrial magnetism. A magnetised bar, of the temperature of 77° F., being placed at a certain distance from the needle, with one end directed towards it, occasioned the needle to make one hundred and two oscillations in 60″. When the bar was cooled down to the freezing point, or 32° F., the needle made, in the same time, one hundred and four oscillations, and when the bar was cooled to 9.5° F., the oscillations were one hundred and five. On the other hand, when the bar was heated to 112° F., the oscillations were reduced to one hundred in 60″; when heated to 167° F. they were ninety eight, and at the boiling temperature, 212° F., they were ninety six.

The fifth result was thus obtained. A piece of wire of soft iron being placed, at length, before a needle, the latter continued to make the same number of oscillations. The wire was then put into a large glass tube, and the temperature of it, by means of snow and ice, was reduced to 9.5° F. The needle, which before had made sixty eight oscillations in 60″, being placed opposite a certain point of the cold wire, made seventy four oscillations in 60″, and placed opposite another point, equally distant from the other end, it made likewise seventy four oscillations. But, when placed opposite the middle of the wire, no change was observed in the number. The temperature, in the course of eight hours, having been restored to its former degree, the needle made the same number of oscillations before every point of the wire. It is, therefore, (says the author,) natural to conclude that a soft iron wire, cooled to 9.5° F., acquires the property of a rod feebly magnetised, and loses it on assuming its original temperature.—*Bib. Univ. Aout*, 1831.

18. *New experiment in Mechanics.*—F. Elice, professor at Genoa, has made known the following experiment. Suspend by a thread F, strong enough to support three kilogrammes, a weight B of 2.9 kilogrammes, furnished with two hooks, diametrically opposite. Fasten to the lower hook another thread F′, capable of supporting one kilogramme. If the latter thread be *gradually* pulled perpendicularly downward, the upper string will always break, and never the lower string; but the reverse will take place if the lower thread F′ be pull-

ed with a jerk, and equally so if it be strong enough to bear five kilogrammes, although in that case, it is stronger than the other. This result is explicable on the principle of the inertia of the weight B.—*Idem.*

19. *Respiration of Plants.*—The opinion of some physiologists, that leaves are the lungs of plants, has been revived by Brongniart, whose researches into the anatomical structure of leaves have demonstrated, in these organs, the existence of a great number of aerial cavities, situated especially on the inferior surface of the leaf, and communicating with the external air by the openings of the stomas. He did not however prove that this enclosed air exerted a physiological effect, analogous to the air employed in the respiration of animals. M. Dutrochet, in a lecture before the Academy, on the 11th of July, states, that having observed that certain leaves, and principally those of the leguminosæ, speedily lost the white tint of their lower surface, when plunged into water, suspected that it was occasioned by imbibition of the fluid into the little aerial cavities. This opinion was confirmed by an experiment, the particulars of which were detailed in his lecture. He has proved that the aerial cavities of leaves are not isolated, but form part of a pneumatic system, which extend continuously throughout the plants. These aerial organs are filled with a gas composed of oxygen and azote, in variable proportions, but of which the oxygen is always in less proportion than in atmospheric air; proving that it has been absorbed by the plant. He further shews by experiment that this internal air is indispensably necessary to the vitality of the plant. Plants breathe, therefore, exactly like insects; that is to say, by a transfer of respirable elastic air, through all their parts. But the origin of this respirable air is not exactly the same: insects draw all their respirable air from the atmosphere which surrounds them; vegetables derive from it only a portion of theirs; they elaborate a greater portion in tissues by the influence of light, so that they can be suffocated both by the air pump and by darkness.—*Rev. Encyc. July*, 1831.

20. *Cultivation of the material used in the fabrication of Leghorn hats.*—The Royal Chamber of Agriculture and Commerce, at Nice, published in 1830–31 two small works containing elementary instructions relative to some points in the agriculture of that vicinity. Among them is the following notice of the grain which produces the material of Leghorn hats.

"This grain is called *Grano Marzuolo*, or Corn of Mars—(Blé de Mars.) Three varieties of it are known, and are equally cultivated and employed, in the neighborhood of Florence. The poorest and most stony soil is the most suitable for its culture, when the straw is the object of research. High and hilly ground is the most favorable. When the soil is thin, two thirds or three fourths more grain is sown than when the grain itself is the material in view; if the soil is rich and firm, six times as much may be sown. The sowing may be at broad-cast, and furrows should be run at suitable distances through the field to collect the rain water, for the straw is not well adapted to the manufacture of hats, if the ground be moist. The most favorable time for sowing, at Florence or Nice, is at the latter end of December, but it may be postponed to the month of March.

In sterile ground the grain should be but thinly covered. The straw is commonly gathered in the latter end of May or early in June. A dry time should be chosen for it, and if it grow in a rich soil it should be gathered earlier to prevent the injury of too coarse a growth. In gathering it, the plant should be pulled up by the roots, for in cutting it, there is a risk of losing the part above the joints, the only portion which is used in plaiting.

It is essentially necessary, in order to procure a well formed and fine straw, that it be gathered when the head is not more than half formed, or when the grain has scarcely begun to show itself. It is then full of juice, which when dissipated leaves the stalk empty and easy to be split. Shortly after it is to be pulled, precisely like flax, gathered into small sheaves, and left in the field to dry, until it is sufficiently cured for storage in the barn.

To prepare the straw for the manufacture, it is to be spread on dry ground, and exposed to the sun and dew, keeping the sheaves distinct from each other, until it becomes pretty well bleached. Four or five days will be sufficient for this purpose, or even less when the dews are abundant. It can be effected, however, only in good weather; all moisture except dew is very injurious, on which account the months of June and July are to be preferred for the purpose.

In Tuscany the bleaching is omitted until the straw is about to be used for plaiting; as soon as it is sufficiently whitened, they separate from each stalk the portion between the ear and the first joint, and this alone is used, the rest being rejected. The portion thus selected is done up into bundles, steeped in water, and when well drained, they are disposed around the walls of a room, (the bundles being as large as possible,) in the center of which sulphur is then set on fire and the room is closely shut. The design of this exposure to burning sulphur is to increase the whiteness of the straw, to give it greater consistence, to destroy insects, and to preserve it from putrefaction.

When this operation is completed, the straw is assorted into thirty or forty qualities according to the size, which determines the fineness of the hats and consequently their price. The plaits are generally made with three straws each, the size depending of course on the relative fineness of the straws which compose them. The beauty and fineness of the hat result from the greater or less number of turns which the plait must take to compose the flat.

The culture of this plant has been successfully attempted upon the driest hills of Nice. The hats made of this straw, in the hospital of that city, under the direction of the Abbe de Cessoles, obtained at the last exhibition of the products of industry of Piedmont, a premium medal.—*Bib. Univ. July,* 1831.

21. *Non-vaporization of a liquid falling in small quantity on an incandescentmetal.*—M. N. W. Fischer by an experiment with concentrated sulphuric acid, has been confirmed in the opinion which he before advanced that the fluid which falls in very small quantity on an incandescent metal is decomposed. This acid when volatilized in the way alluded to, flies off in a thick bluish vapor, which is perfectly respirable, and occasions not the least cough, an effect which, as is well known, is immediately produced by the evaporation of undecomposed sulphuric acid. The sulphuric acid he supposes is decomposed into oxygen and an oxide of sulphur, which constitute the innoxious vapor. He was unable for want of a tubulated platina retort, to ascertain whether the latter compound is a new acid, or one of those already known, e. g. the hyposulphuric. It cannot as he states be simply sulphurous acid ; because it is unattended with any peculiar odor.

He has proved that the same phenomena occur with heated glass and porcelain as well as with metals, especially when liquids are employed more volatile than water.—*Bib. Univ. Oct.* 1831.

22. *New method of producing perspiration in Cholera Morbus.*—Dr. Tribolet, of Berne, has found that the best mode of effecting this object, is to put the patient into an empty bathing tub in which a spirit-of-wine lamp is made to burn. The tub is covered with a carpet so as to concentrate the vapor which arises from the combustion. In a few minutes all the air beneath the carpet acquires a high temperature, and produces an abundant sweating of the patient. This method has been repeated at Geneva with results exactly similar to those of the Bernese Physican.—*Idem.*

23. *New Compost.*—M. Simonin de Sire, a land holder near Dinant, asserts that the vines of early potatoes, may, without any injury to the produce of the root, be mowed down immediately after the flowering, and converted into a rich compost by laying down 1st, a bed of earth, 2d, a thin stratum of quick lime, 3d, a thick bed of the vines, 4th, a stratum of lime, 5th, a layer of earth, &c. The mass ferments, but it ought not to be disturbed till the following spring. Nettles and all other weeds may be treated in the same manner.—*Idem.*

24. *New size for the Chain of Woven Cloth.*—To prevent the great unhealthiness arising from the low and damp situations in which weavers find it necessary to perform their work, in order to secure the requisite moist condition of their tissue, various methods have been resorted to, depending chiefly upon the deliquesence of certain salts; which by attracting moisture from the air, have enabled weavers to conduct their business in more elevated and healthy situations. Formerly, sea water which contains chloride of magnesium was used, also urine; more recently a solution of chloride of calcium. But the objection to these saline ingredients is that they eventually injure the stuff, especially in moist weather, on which account many weavers have renounced the use of them.

M. *Morin*, a chemist of distinction, having observed that all deliquescent salts have this injurious tendency, has sought for a hygrometric substance which is free from this objection, and he conceives that he has found it in a solution of the extract of lichen. This has been tried by a number of intelligent weavers, whose testimony to its efficacy is given in his paper. It produces no unpleasant effect upon the stuff, and it enables them to erect their looms in dry and healthy situations.

Preparation of the size for Cotton or Linen.—Boil, during half an hour, four kilogrames of Lichen Islandicus in twenty four litres of water. Strain it while hot through a fine cloth. On cooling it acquires a gelatinous appearance. Dilute in three litres of water a pound of wheat or rice flour, and heat it to the consistence of thick pap, stirring it continually. Mix it, while hot thoroughly with the decoction of lichen. This quantity of mixture furnishes about forty five pounds of dressing of a suitable consistence, and which costs, including the fuel, two francs, fifty five cent. or about six centimes ($\frac{6}{100}$ fr.) per pound. A watery fluid separates from it after being kept a few days which does not injure its use.

The grey tint of this dressing may deter some workmen from the employment of it; this defect, if it be one, may be in a great measure prevented, by previously macerating the mass for thirty six hours in water, working or kneading it from time to time, and then washing it in three or four waters, and boiling it half an hour, straining and proceeding as before described. By this means it furnishes a size much less colored.

This decoction is not sufficient of itself for linen thread, which is much more difficult to dress than that of cotton. The author on this account adds to it one third of its volume of common size of wheat flour, which succeeds completely. With this addition the weaving of linen may be conducted in any situation, the cloth having the same softness as that of cotton. By the use of the lichen decoction another important advantage is gained, viz. there is no risk of oversizing. There are few weavers who can manage their dressing with entire success, and it is well known that when badly done, the threads are extremely liable to break. With this new dressing, the workman may easily, if he choose suspend his work till the next day.

During frosty weather, the weaving is very difficult in consequence of the rapid drying of the size. The lichen paste dries also, but it preserves the elasticity and suppleness of the thread in a suitable state for the loom. The conclusions of the author are:

1. That by the use of the lichen dressing, weavers may place their looms in an airy and elevated situation, even in a current of air, and work at all temperatures.

2. That it is adapted to all kinds of stuffs,—producing none of the spots which arise from the use of the hygrometric salts.

3. That it is applicable not only to cotton cloth, but also to that called *cretonnes*, by its cheapness and the velvety aspect which it communicates.

4. That it has the peculiar advantage of allowing the workman to weave on the next day, without breaking a great many threads, the chain which he had prepared in the evening.—*Bull. d'Encour. Avril.* 1831.

25. *French Ultramarine.*—The price of the Artificial Ultramarine, the process for manufacturing which has been discovered by *M. Guimet* of Paris, (V. Am. Jour. XV. 392,) has been so reduced as to make it an object with painters and colormen, in point of economy, to substitute this article in the room of cobalt in the bluing of paper, thread, and stuff in which this material is employed. The discoverer has purchased a situation three leagues from Lyons, in which he is about to establish a manufactory on a scale, sufficiently large to satisfy the demands of commerce.

M. Guimet has proved by trial, that a pound of his ultramarine of the second quality, and which can be afforded at twenty francs, will blue as much paper as ten pounds of cobalt, which at wholesale, costs twenty six francs, and an important advantage of the former is that on account of its lightness, it spreads more uniformly over the paper.

Since his success in this application of the new color he has tried it in dyeing, and has obtained upon linen, cotton and silk, a degree of success which encourages the hope of an ultimate and decided superiority over indigo.

In his printed circular, M. *Guimet* offers his ultramarine for bluing paper at sixteen francs. Report of M. Merimée to the Societé d'Encouragement.—*Bull d'Encour. Avril,* 1831.

26. *Singular Case of Odoriferous Emanations.*—In the 34th Volume of the Memoirs of the Royal Academy of Sciences of Turin, (1830) Dr. Speranza of Parma relates the case of an individual whose left fore arm emitted an odor of Amber, or of Benzoin, or Balsam of Peru. The odoriferous emanations were sometimes so strong that they filled the whole of the large room in which the Doctor conducted his experiments upon this personage, whom he suspected at first of some charlatanry, but of whose sincerity he was soon convinced. He was a man of thirty four years of age, of a robust constitution, (having, until that time enjoyed constant health) agreeable eyes, expressive features, dark thick hair, a ruddy countenance, muscles prominent,—a man of ardent feelings and quick penetration; to whom nature had been liberal in her endowments. It did not ap-

pear that electricity had any part in the production of this singular phenomenon. An attack of bilious fever, in the course of two months, destroyed the cause, and the effect did not return after his recovery.—*Rev. Encyc. Juin,* 1831.

27. *Gelatine of Bones.*—A memoir presented to the French Academy, by M. Donné having thrown some doubts upon the wholesomeness of Gelatine, M. Darcet made the following summary. Butchers' meat contains per one hundred pounds at a medium.

Dry meat, - - - - -	24
Water, - - - - - -	64
Bones, - - - - - .	15
Total,	100

Bones contain per hundred:

Earthy matter, - - - - -	60
Gelatine, - - - - - -	30
Fat, - - - - - - -	10
	100

Thus, the 15 parts of bones in butchers' meat may furnish 6 parts of pure animal substance, and therefore 100 lbs. of meat, which commonly yield but 24 of alimentary substance, may furnish 30 lbs. if care be taken to extract the whole. It is obvious, therefore, that four head of cattle may supply as much nutriment as is now obtained from five. This is an enormous waste; and to prove the wholesomeness of gelatine, M. Darcet states, that a committee of the faculty of medicine, composed of Leroux, Dubois, Pelletan, Dumeril and Vauquelin, distributed gelatine to forty patients, and reported, 1st, that it was not only a great improvement as an article of diet, but economical, and that to an extent which ought not to be overlooked; 2d, that soup made with gelatine is at least as agreeable as the ordinary soup of hospitals; 3d, that gelatine is not only nourishing and easy of digestion, but very salutary, and is attended with no unpleasant effects on the animal economy. In the hospital St. Louis, there is an apparatus which furnishes 900 rations of broth per day. It has been in operation twenty months, and has supplied 550800 rations of gelatinous solution, and various reports made to the administration testify to its value. At the Hotel Dieu 443650 rations have been supplied, with the same result. These facts M. Darcet thinks ought, at least, to induce the Academy to suspend its judgment, before it harbors a sentiment unfavorable to the wholesomeness and economy of gelatine. *Rev. Encyc. Juin*, 1831.

28. *New instruments for measuring heat.*—On the 5th of September, MM. Nobili and Belloni presented an instrument of their invention, which they called a thermo-multiplicateur, by means of which they are able to appreciate changes of temperature, so small as to be undiscoverable by any other instrument. The principal piece of the instrument is composed of thirty eight elements, (antimony and bismuth,) united in very acute angles. The second piece is a galvanometer of two needles, particularly adapted to a thermo-electric current. The instrument, therefore, depends upon electro-magnetic changes, which are themselves consequent upon the changes of temperature, which the instrument is thus intended to indicate.

One of their first trials with the instrument enabled them to discover a serious imperfection in all the thermoscopes in common use. When a plate or blade of glass is exposed to the sun or any other source of radiant heat, a portion of the heat passes immediately through the transparent body, but another portion is arrested by the first strata, and being there accumulated it advances by degrees to the posterior surface. The first portion is so much less in relation to the second as the temperature of the source whence it issues is the less elevated; the result evidently is, that if the rays proceed from a very feeble source, this first portion is reduced to almost nothing. Those thermoscopes, therefore, which are covered (as they nearly all are) with a cage of glass, are placed under very unfavorable circumstances. The new instrument is not subject to this difficulty, and in consequence it indicates the instantaneous passage of a body slightly warmed, while the thermoscope of Reaumur remains completely insensible.

In general, the instantaneous passage of calorific rays through transparent bodies, depends on their degrees of transparency, and this relation appeared constant in all the substances which they first tried, viz. sulphate of lime, mica, oil, alcohol and nitric acid; but the law was found to be completely at fault with respect to water. This liquid, in fact, as the authors found, intercepts the instantaneous passage of the calorific rays and stops it completely; so that, however thin the stratum may be, when such a diaphragm is interposed, a red hot ball may pass at a little distance before it, without causing the least movement in the needle. It was difficult, after having observed the immediate permeability of alcohol, oil and nitric acid, to believe that the non-permeability of water depended on its liquidity. Experiments, however, made with water in the solid state, have not varied the result. This property of water seems, therefore, to depend on its chemical composition and not on its physical condition.

The third series of experiments was made to determine the specific heat of insects, of phosphorus, and of the lunar rays.

With respect to insects, it has long been thought that their temperature was that of the circumambient air. It is certain, however, that these animals respire, that carbonic acid is formed by them, and consequently that a slow combustion must be going on which ought to produce some elevation of temperature. Davy was of opinion that their temperature was superior to that of the atmosphere. In fact, by introducing a very small thermometer into the bodies of insects, a slight elevation of the mercury generally occurred. In two cases, however, there was a depression. But the method employed by Davy was very imperfect, 1st, because it is applicable only to very large insects; 2d, because the mass of the thermometer being very large in proportion to that of the animal, the instrument would produce, by contact, a great subtraction of caloric; 3d, because the evaporation of the humors, leaking through the incision, would cause a reduction of temperature; and 4th, because the experiments must always be made upon an animal in a suffering state.

With the thermo-multiplicateur these inconveniences may be avoided. The experimenters were able, by the arrangement which they adopted, to test the temperature of the insect, in a state of perfect ease and freedom from constraint,—and the result was, that in every case, the instrument indicated a positive increase.

On comparing the results obtained with lepidopterous insects in their different states, MM. Nobili and Belloni arrived at a constant law, viz. *that caterpillars always have a higher temperature than the butterflies and chrysalids which proceed from them.* Now, as the respiratory apparatus of the caterpillar is more fully developed, and respiration more active, than in the perfect insect, it results that the theory which attributes animal heat to a slow combustion, is supported by the phenomena of insect life, as well as by those of the vertebral animals.

There are various bodies which, like insects, give reason to believe that they possess a temperature somewhat different from that of the atmosphere: the same test establishes this fact. It is thus that a deviation of 50° is obtained by placing in the apparatus a very small piece of phosphorus, which, in contact with the most delicate thermometer, gives no indication of heat.

The authors then endeavored, by this delicate instrument, to estimate the calorific influence of the lunar rays,—but so many unexpected difficulties occurred in their attempts to remove the various causes of fallacy in the performance of this experiment, that they have not hitherto succeeded to their satisfaction.

A slight modification of the apparatus enabled the authors to estimate the radiating, (émissif,) absorbing and reflecting powers of different bodies. Mercury proved to have the highest reflective power among the metals; and the others followed in the order pointed out by Prof. Leslie. But one new fact which they ascertained is, that polish has very little effect in increasing the reflective power. Thus, in comparing the amount of reflected heat from a plate of brass, rough from the casting, with a similar plate which had received the highest polish, a difference was apparent of only two degrees in thirty six.

Their researches into the power of emanation only served to confirm the laws already known; but the absorbent power furnished some remarkable results. The method of experimenting was this—the substance whose faculty of absorption was to be examined, was pasted to a disk of tinned iron, to the other side of which was fastened a stem perpendicular to the surface. After an exposure to the solar rays, these pieces were presented in pairs to corresponding sides of the instrument, and the magnetic index turned to the side of that which was most heated. As a counter proof, it was only necessary to change sides, and to ascertain the fact of a contrary movement.

In this way the relative absorbing power was well ascertained, and the constant result was, that *the absorbing power is precisely in the inverse ratio of the conducting power of the same substance.* Thus, with respect to stuffs, the color being the same, the absorbing power was in the order of *silk, wool, cotton, linen* and *hemp.* The conducting power is just the reverse. So among the metals, the scale of conductibility, as is well known, is *copper, silver, gold, steel, iron, tin* and *lead.* The absorbing power, agreeably to the instrument, is exactly the reverse.

From these and other trials, the fact appears to be established, that, circumstances being equal with respect to color and condition of surface, the absorbing power of a body is greater as its conducting power is less.—*Rev. Encyc. Sep.* 1831.

29. *Advantages of Bored Wells in communicating heat.*—The temperature of the water which rises from considerable depths in the earth, being almost constantly, winter and summer, at about 54° Far. the application of this temperature to economical purposes was suggested by M. *de Bruckmann*, of Wirtemberg, and it has met with complete success. Bored wells, from which the water rises to the surface by some internal force, and flows in a constant stream, are now common or at least numerous, in the north of Europe. This able engineer had bored a number of these wells for the supply of various establishments for spinning, paper-making, bleaching, &c. in which the water flowing from them, is used as a motive power.

In the winter of 1830, he was consulted in relation to the best means of keeping the wheels clear of ice, in one of the manufactories of Heilbsonn, when the congelation was so great as to oblige them to use the axe in clearing the wheel. Recourse had been had to currents of hot air, and to cylinders filled with ignited charcoal, but with only imperfect success. Dr. *Bruckmann* introduced the current from a bored well into a cylinder, pierced full of holes from which the water fell in a shower upon the wheel, and in less than an hour, the wheel which was so encased in ice as to be immovable was as clear of it as it is in the month of July, and from that time no further obstruction was experienced. This beneficial application of the warm water of bored wells, was soon extended to all the manufactories where such wells existed.

But the engineer did not rest there. He conceived and executed the plan of warming the manufactories themselves by this water, prior to its falling on the wheel. This was done by the simple process of causing the water to circulate in open tubes (troughs?) throughout the several rooms of a papermill and thence to fall on the wheel. A difference of nearly thirty five degrees, in very cold weather, was thus produced between the interior and exterior of the building, although the doors were frequently opened by the ingress and egress of the workmen, and it enabled the proprietor to dispense with the stoves and furnaces, without any inconvenience to the laborers either on account of heat or of dampness from the water, which was at first an object of apprehension.

In oil mills this procedure is particularly advantageous, not only in keeping the wheels clear of ice, but in securing the requisite dampness of the grain, without the danger of freezing, which in extremely cold weather, demands much troublesome precaution.

The process now described has the further advantage. 1st, that the same water which in winter warms the apartment, in summer communicates a most agreeable and refreshing coolness, the heat never exceeding fifty five degrees, though it may outside be as high as seventy six degrees. 2nd. That the circulation of water in manufactories purifies the air and promotes the health of the workmen, so that in rooms full of people, the atmosphere is found to be perfectly free although the windows may be kept shut. 3d. That in case of fire, a current of water within a building must be of the greatest consequence.

So successful have been these inventions of M. de Bruckmann, that the King of Wirtemberg has appointed him to the station of Royal Architect, and Knight of the order of merit, and decreed to him a large gold medal.

The water of bored wells has been applied in France to the warming of conservatories of plants, and a large fish pond at Montmorency has been supplied in the same manner with cool water, which in the summer season, prevents the loss formerly sustained by the perishing of the fish from excess of heat. In consequence of these valuable applications, the committee of the "Societé d'encouragement," propose the decree of their gold medal to M. de Bruckmann.—*Bull. de la soc. d'encour. Aout*, 1831.

30. *Limits of the Audibility of Sound.*—M. *Savart* read a memoir on the inferior limit of the number of vibrations per second which compose a sound just perceptible to the human ear. He had before proved by experiments communicated to the Academy, that the superior limit was much farther extended than had generally been imagined: for example, that sounds are very distinctly heard, which result from more than forty thousand simple oscillations in a second. By means of a new apparatus, which he describes, he now shews that sounds are distinctly perceptible, and even strong, when composed of no more than eight vibrations in a second.—*Rev. Encyc. Juillet*, 1831.

31. *On the Sleep of Plants.*—M. Virey, in a memoir entitled, *Flore Nocturne*, (Flora nocturna) announces the following results or laws which he has deduced from his researches on this subject. Cold and humidity diminish the transpiration of vegetables; the sap, then instead of ascending to the summits of the leaves and flowers, as during the day, descends towards the roots. Hence, the sap vessels of those parts, frail and fine as they are in many plants, become almost empty and contract by their own elastic force. This is the reason why so many compound flowers, the Malvaceæ, the Convolvuli, &c. close during the night or even when the sky is covered with clouds. For a similar reason a numerous class of plants with pinnated leaves, fold them and sleep during the night. The returning warmth of the sun, again sets the sap in motion, and again invigorates the leaves and petals. The heat and light dilate the vessels with a sort of turgescence, and expand the foliage until the return of night again drives the sap from their delicate vessels. But why is it otherwise with nocturnal plants which appear to languish and to be overcome during the day, and unfold their beauties only when the sun is withdrawn. It is because his ardor acts too powerfully upon the frail texture of certain petals—evaporates too rapidly their nutricious juices, and causes them to close. But during the freshness of the night, these juices remain in the tissue of the plant, fill their tubes and unfold their surfaces to the atmosphere.—*Rev. Encyc. Aout*, 1831.

32. *Shower of Flies. Singular appearance of the Moon.*—At the session of the Academy of St. Petersburgh, held 21st of February, 1831, a singular phænomenon was described which occurred at Oremburg, on the 14th of December, 1830. During the whole of that day it rained heavily, although the thermometer remained at the freezing point. About midnight loud thunder was heard in the northwest; and on the 14th of December snow fell, accompanied by a multitude of small black gnats, whose motions were similar to those of the flea. The next day the atmosphere was clear, and the temperature fell to ten degrees below. At the same session a letter was read from the Governor of Oremburg, stating the following facts. On the 19th of January, 1831, between 6 and 8 P. M, the evening being fine, the new moon appeared surrounded with a circle of fire, perfectly regular, and cut by two diameters of fire equally regular. The moon occupied the center of the circle. Two white semicircles were very distinctly delineated at the extremities of the diameter which went from E. to W. and their light was extended almost

to the extremities of the other diameter. On the north of the circle a small arc of fire was visible. During the continuance of this phenomenon the atmosphere was pure and tranquil, and the cold did not rise beyond seventeen degrees of Reaumur; a short time after, the thermometer descended to twenty nine degrees below freezing.—*Rev. Encyc. Mai,* 1831.

33. *Improved Blowpipe.*—This instrument, as simplified by M. DANGER, (V. Am. Jour. Vol. 17, p. 163) has been found by experience to answer a very valuable purpose in the blowing and working of glass. It is far less expensive, and is stated to be more powerful and manageable than the enamellers' lamp. M. *Danger* has acquired so much skill in the use of his blowpipe, as to manufacture a great variety of philosophical apparatus in glass, such as sucking and forcing pumps, steam engines, air pumps, &c. and he so adapts the different parts of these instruments to their respective purposes as to enable the operator when a particular piece is broken, to replace it by another, without the necessity of procuring a new instrument. M. *Danger* has reduced the art of glass blowing to a few simple principles which are applicable to the construction of all sorts of apparatus; and the best proof that can be given of the readiness with which he communicates them, is the number of pupils which he has taught within two years;—four hundred at least, have learned from him every thing necessary to the construction of the most complicated apparatus. Twelve lessons are quite sufficient for acquiring the whole detail of the operations, and even six may be sufficient to enable the pupil to dispense with further instruction.—*Report of de Claubry. Bull. d'Encour. Jan.* 1831.

STATISTICS.

1. *On the law of increase in the human stature,* by M. QUETELET, *Brussels.*—After a few general considerations, the author mentions the facts which he has ascertained relative to the mean stature and the growth of man in Southern Brabant.

The size of children, taken at the moment of birth, as derived from a hundred cases of actual and careful measurement, in the foundling hospital at Brussels is as follows, viz.

	Minimum.	Mean.	Maximum.
Boys,	16 in. 2 lines.	18 in. $5\frac{3}{5}$ lines.	19 in. 8 lines.
Girls,	16 2	18 $1\frac{1}{2}\frac{4}{5}$	20 6

The mean height of boys is, therefore, in metrical measurement 0.4999, and that of girls 0.4896; these are inferior to the measurements observed in Paris as stated in the Dictionnaire des Sciences Medicales.

Under the former government of the Low Countries the militia recruits took place at the age of nineteen. The following table, for Southern Brabant, during the years 1823 to 1827 inclusive, comprehends the mean of 45,500 measurements of young men.

	Districts.	*Mean Height.* Metres.
1.	Brussels,	1.6633
	The vicinity,	1.6325
2.	Louvain,	1.6393
	The vicinity,	1.6177
3.	Nivelles,	1.6428
	The vicinity,	1.6323
	Towns,	1.6485
	Country,	1.6275
	Mean,	1.6380

The inhabitants of the towns are, therefore, taller than those of the country, at least at the age of nineteen.

Under the French empire, in the departments of Old France, the mean height of young men of twenty was 1.615 metres, while in Brabant, M. Quetelet found it, for young men of nineteen, to be 1.638. Belgium, it may be observed, is a richer country than the medium of France.

It thus appears that, by a general law, the mean of the human stature at nineteen and twenty is greater in proportion to the ease, comfort and freedom from excessive fatigue which the population generally enjoy.

But another question remains to be examined, viz. whether the growth is not simply more precocious in cities and rich countries. M. Quetelet has not decided that point, but he has made a curious observation with respect to the period at which the human growth ceases. He examined the results obtained during an extraordinary muster about fifteen years ago at Brussels, and made a comparison among nine hundred individuals, viz. three hundred at nineteen, three hundred at twenty five and three hundred at thirty years of age.

		Metres.
He found the mean height at nineteen,	- - -	1.6648
" " " " " " twenty five,	- -	1.6750
" " " " " " thirty,	- - -	1.6841

The result according to his table is uniform, that is, it is the same on a comparison of one hundred of each age, as of three hundred.

It thus appears that the growth of men does not always stop at the age of twenty five. It is not even proved that it stops at thirty, but it may be inferred from the author's observations, that in a majority of cases it ceases at nineteen, twenty five or thirty, but that a small number, still more tardy, continue to increase the mean height.

The author obtained from the schools and public establishments of Brussels, documents of the height of children of different ages and sexes. He has represented the mean growth of men by a curve which is very nearly a hyperbola, and is represented by the equation of the third degree, $y+\frac{y}{1000(T-y)}=ax+\frac{t+x}{1+\frac{4}{3}x}$, in which, y and x are co-ordinates, expressing the height and age, t and T, two constants, the height of the individual at his birth, and at his entire development. It is quite a singular circumstance that this formula, calculated upon the height observed at birth and nineteen years of age, answers also for the increase observed by physiologists in the five months which precede birth.

M. Quetelet terminates his work by the following summary :

1st. The limits of growth in the two sexes are unequal, because women are born smaller than men, and sooner attain their full development, and their annual growth is less than that of men.

2d. The height of the inhabitants of cities surpasses, by two to three centimetres, that of the inhabitants of the country, at the age of nineteen.

3d. It does not appear that the growth of men is entirely finished at the age of twenty five.

4th. Youth who belong to families in easy circumstances, and who devote themselves to study, generally surpass the mean height.

5th. The growth of the child, even from several months before birth, until its completion, follows a law of continuity such that the increments diminish successively with the age.

6th. Between five and sixteen the growth is nearly regular; and is the twelfth of the increase of the fœtus in the months which precede birth.—*Bib. Univ. Sept.* 1831.

2. *Longevity of trees.* (Morgenblatt, May, 1831.)—In the district of Rossienie, in Samogitia, Poland, the principal town of which is of the same name, thirty miles from Kowno, there was formerly seen at the country house of a citizen of the name of Degonisius Przkinwicz, an enormous oak, which the country people called Baublis. This tree, which had been an object of worship in pagan times, having suffered by a fire, which had injured its roots, the proprietor had it cut down in March, 1812, and transported to his park. When sawed through, its age was clearly discoverable, and found to be almost six hundred years. The trunk of this Nestor of the vegetable kingdom was 38½ French feet in circumference and 14 Fr. feet in diameter. The owner had it hollowed out into the form of a hall, 26½ Fr. feet in circumference, and ornamented with portraits of illustrious Poles and other great men. At the passage of the 10th corps of the French army, in 1812, under Gen. Macdonald, this trunk excited the admiration of the French.—*Bib. Univ. Aout*, 1831.

3. *Connection between civilization and mental aberration.*—A work entitled "The political arithmetic of madness, or general considerations on madness in its relations to ignorance, crime and population, in various parts of the globe," by M. Pierquin, contains numerous comparative tables, by which it appears evident that the progress of knowledge and the arts is very favorable to the extinction of mental diseases, and to the extirpation of crime; while it is clearly shown by the criminal statistics, both of France and England, that immorality increases in proportion to the ignorance and misery of the people.

His tables show,

1. The relation between the number of maniacs, and of those who are accused of crime, comprehending both sexes, the professions of each, and in what proportion mental aberration is caused by each of them.

2. The influence of education and the nature of the crimes committed by individuals under arrest.

3. Accidental deaths, suicides, duels arising from gaming, and lotteries.

4. Of the civil condition of maniacs,—whether single, married, widows, or persons divorced.

From the facts thus exhibited, M. Pierquin draws the inference, that the number of insane, and of criminals, depends on the amount of intelligence among the people, and that wherever ignorance prevails, idiotism and its intellectual varieties will be frequent, so that the chance of insanity and crime increases in proportion to the general ignorance; and that intellectual aberrations tend inevitably to increase the amount of crime.—*Bull. de la Soc. de Statist. Univ. septième livraison.*

NECROLOGY.

1. FREDERICK PHILIP WILMSEN, the first preacher of the parish church of Berlin, died in that city on the 4th of May, 1831, at the age of sixty one. He was born in Magdeburg, the 23d of February, 1770. By his ministerial functions of thirty-four years and his numerous writings, Wilmser has rendered great services to the cause of education. Throughout his career, he displayed a remarkable degree of mildness and perseverance. He has been styled the Berquin of Germany. His *Friend of Youth* has passed through more than a hundred editions of fifty thousand copies, and certainly next to the sacred scriptures, has been the most numerously printed work of our age. His other works comprehend most of the branches of education. His literary ardor accompanied him to his bed of suffering, and on the very day of his death appeared the last sheet of his "*Natural History.*"—*Rev. Encyc. Nov.* 1831.

2. EDWARD THOMAS, of Cayuga county, New York.—We regret to learn that this interesting young man, who gave proofs of much promise in the practical sciences, and from whose pen there are two articles in our Journal, on the construction of optical instruments, has paid the last debt of nature. He died on the 20th of May, of pulmonary disease, after an illness of five months.

"The sublime views of astronomy (observes one of his intimate acquaintances) first gave him a partiality for that science; and a strong desire to explore the depths of ether, made him a scientific and practical optician, and perhaps without a superior in the United States. The grand features of geology were very attractive to him, and in consequence he became a mineralogist. Several years of debility induced him to read the latest and best medical authors with great attention, and when his last illness supervened, he was preparing for the American Journal, a paper on some diseases of the eye which had been but little noticed by former writers, and which his great optical skill enabled him most particularly to examine."

Miscellaneous contributions; by Charles U. Shepard.

1. *To destroy weeds in the alleys of gardens.*—A rainy summer is favorable to the multiplication of weeds. They are often cut and pulled up; but, besides this method being expensive, it operates to injure the alleys. The rain water which often stands in the gullies, softens the earth, and the alleys soon become deranged, and render it necessary to have recourse to expensive repairs. This remedy is also insufficient: the delicate extremities of the roots are broken; the plants shoot up again, and the same labor is to be repeated. Equal damage is done to the alleys when they are treated with a scraper.

A more sure, more expeditious and less expensive process to accomplish the same end, is to water them with the following solution which destroys the plants even to the roots.

Boil about a hundred *litres* of water in a cauldron of iron with twenty pounds (livres) of quicklime and two pounds of sulphur: let this liquid settle: add water as may be necessary for the pavement of the alleys; the plants will disappear for many years.—*Recueil Industriel, Sept.* 1830.

2. *Preservative against flies, employed by the butchers at Geneva.*—A French gentleman, who lived in Geneva a long time, relates that the butchers of that city have possessed, from time immemorial, a method of protecting meats from flies. It is by the odor of the oil of laurel. This oil, which though a little disagreeable is not insupportable, will drive away the flies; and they will not approach the wall or the bench which has been rubbed with it. I have, says the person, made the experiment, and by this means protected the gilding of furniture from the approach of flies.—*Idem.*

3. *Coloring materials suitable for confectioners and distillers.*—*Blue colors.*—Indigo, which is often dissolved by sulphuric acid.

Prussian or Berlin blue.—These colors mingle easily with all others, and afford all the compound tints of which blue is an element.

Red colors.—Carmine, Carmine lake.

Yellow colors.—Saffron, *La graine d'Avignon*, *La graine de Perse*, *Le quercitron.*

The *aluminous* lakes of these substances.—The yellows which are obtained with many of the substances already described, are more brilliant than that which the chrome yellow produces, and whose employment is so dangerous.

COMPOUND COLORS.—*Green.*—This color may be produced from a mixture of blue and of various yellows; but the shade which is the most beautiful is obtained from the Prussian or Berlin blue and the *graine de Perse.*

Violet.—Indian woods, Berlin blue. By various mixtures, all desirable tints are obtained.

Liquors.—In coloring liquors, the preceding colors may be employed; but some others may be necessary which are derived from the following substances.

Blue liquors.—Indigo dissolved in alcohol. The solution is made by treating indigo with sulphuric acid, and pouring alcohol into the liquor, which takes up the coloring matter.

Substances whose use in confectionary is dangerous.—All mineral substances, Prussian blue excepted, particularly *chrome yellow,* which is formed of two poisonous ingredients.

Schweinfurt green, a violent poison which contains copper and arsenic.

Some distillers employ sugar of lead for the clarification of their liquors; a process which is liable to occasion the most serious accidents, as this substance is a violent poison.

Much care is requisite also as respects the colored papers employed by confectioners; as children frequently chew them and are exposed to be poisoned if they are stained by mineral substances.—*Recueil In. Dec.* 1830.

4. *To protect iron and steel from rust.*—Heat the object until it burns the hand; after which, rub it with very white wax. Heat it a second time in order to melt off the wax, and then rub it briskly with a piece of cloth or leather to impart to it brilliancy. This operation renders the metal proof against rust from exposure to the atmosphere. —*Idem.*

5. *A new plant which furnishes a wholesome and limpid water.*—The English have discovered in the countries which they have recently added to their empire in India, a shrub, the stem of which when cut, furnishes a great quantity of pure and limpid water. The natives are very familiar with this precious property; in consequence of which, it is very rare to find a whole and well preserved plant

of this kind. It climbs up trees to a very great height; it has not yet been described.—*Recueil Industriel, Avr.* 1830.

6. *New species of plants discovered in Siberia.*—Doct. Zedebuhr on returning from a scientific journey, undertaken by the order of the government of Russia, in the year 1826, announced to the senate of the university of Dorpat that he had gathered in the mountains of Altai, in Siberia, sixteen hundred plants, among which are about five hundred new species.

The animal kingdom has afforded him a collection equally great: the species which he has collected amount to more than seven hundred.—*Idem.*

7. *New method of transplanting trees.*—It often happens in replacing a dead tree in an avenue or grove that, in order to enjoy the benefit of its shade the sooner, the tree which is transplanted has already acquired considerable size.

After having dug around the tree, a distance sufficiently considerable so as not to detach the earth about the roots, the mass was surrounded with a coarse cloth in order to retain the earth, and it was then disposed in a hole prepared beforehand.

Notwithstanding all these precautions, it was not rare for the trees to die, on account of the disturbance of the roots.

The method we propose is more simple, and does not present the same inconveniences, although it is applicable only in northern climates and during rigorous winters. It is accomplished simply by raising the tree with the earth which surrounds the roots, when the frost unites the whole into a solid mass, and to transplant it into a hole dug the autumn before.

This method, by which the tree does not undergo any violence, is equally well adapted to young trees as to shrubs.—*Idem.*

8. *Imitation of platina.*—Melt together a pound of brass and ten ounces of zinc; but as the brass is composed of copper and of zinc, in the proportion of three pounds and a little more of the first, and of a pound of the second of these metals, equal proportions of copper and zinc produce the same imitation of platina.—*Idem.*

9. *A new method of dyeing hats.*—It is known that nutgalls are a very expensive ingredient in dyeing hats. M. Ludke formed the idea of substituting for it, a simple decoction of oak bark.

This decoction enables us to dispense with the use of lees of wine which are no longer necessary; and the felt is found sufficiently prepared to receive the dye.

To make this decoction, he took half a cwt. of oak bark which was boiled a number of times and with different quantities of water, even to two *oxhafts.* He took afterwards eighteen pounds of this decoction for a bath of dye, capable of employing six workmen.

He then added to it a little cream of tartar, with a small quantity of vinegar and a small portion of the lees of wine, and proceeded as usual.

In the second bath of dye, he added only half the quantity of wine employed in the first. In order to obtain the best results, as in the case of choice felts, he found it necessary to increase the quantity of cream of tartar, as well as of vinegar and of lees of wine.

It is proper to remark that, although the process of dyeing may be completed by a pure decoction, the mass, nevertheless, does not acquire the suppleness which is desired.—*Recueil Industriel, Nov.* 1831.

10. *Blue coloring matter extracted from the stem of the buck-wheat.*—(*Polygonum Fagopyrum.*)—A blue coloring matter, very well adapted to dyeing, is obtained from this plant by treating it in the following manner. The stems are cut before the full maturity of the grain and spread upon the ground exposed to the sun, and suffered to remain in this situation until the seeds drop off with ease. When the grain is separated from the stems, they are thrown into heaps, moistened with water, and left to ferment to such a degree that decomposition takes place and a blue color is developed. It is then formed into balls, or flat cakes, which are dried in the sun or in a stove. After which the balls, being boiled in water, communicate to it an intense blue which is not affected by vinegar or by sulphuric acid. This color is converted into red by alkalis, to black by powdered nut-galls, and to a very fine green by evaporation. Stuffs dyed blue with this preparation, in the same manner as they are dyed with other vegetables colors, appear very handsome and retain their color very well.—*Recueil In. Sept.* 1831.

11. *Heating of water.*—M. Dulong has communicated a note by M. Lechevalier, upon the heating of water in vessels made red-hot. It has been known for a long time, that when drops of water are projected upon metal raised to a white heat, that instead of un-

dergoing a sudden evaporation, they experience a slow one, and that instead of spreading themselves, as is the case at a common temperature, they suddenly assume a spherical form like drops of mercury on glass. It is also known, that when the metal, in cooling, has reached a temperature below that of a dull red heat, the drops of water become flattened on their surface, and undergo a sudden evaporation, accompanied by a brisk ebullition. The same phænomena have been observed to attend the heating of a considerable quantity of water. It has been remarked that, by pouring water, drop by drop, into a platina crucible raised to a white heat, the crucible might be filled almost completely, and preserved for a long time in this condition, without undergoing any very perceptible evaporation; but that when the crucible was removed from the fire, and permitted to cool down to a dull red heat, the water suddenly enters into a violent ebullition and is rapidly converted into vapor.

These facts were explained on the supposition, that at a red heat the water is not in contact with the sides of the vessel, and that the radiant heat, which alone penetrates it, passes through it almost entirely without heating it, so that the feeble elevation of temperature, which results from the slight proportion of heat left in its passage, is more than compensated by the evaporation which takes place at the surface of the liquid. Not satisfied with this explanation, M. Lechevalier undertook a series of experiments to ascertain the true theory of these phænomena. He constructed a cylindrical boiler of copper, six inches in length, and one inch in diameter, whose sides were two lines in thickness, and pierced at one of its extremities by a round orifice, two lines in diameter. After having filled it with water, he closed it with a plug of wood, which was encased by a strap of iron in order to secure it in its place. After having left it forty eight hours with the orifice downwards, in order that the plug might swell so as completely to occupy the opening, he subjected the boiler to a red heat by means of a forge. He then withdrew the plug; but no vapor escaped, although the boiler contained a certain quantity of water. It is necessary to unplug the boiler while it is still red hot, and to do it without loss of time; for when it has fallen to a temperature below redness, the liquid it contains is rapidly converted into steam accompanied with detonation, and giving at the same time a recoiling motion to the boiler. In an experiment where the cooling was suffered to take place upon the floor of the forge, the explosion was equal to the report of a pistol, and the boiler was projected with violence against the wall of the building. It follows from hence, that if it be admitted that the temperature of water placed in a vessel, heated to redness, is less than 100° R., it is necessary to admit also that in the preceding experiment, the water, which, before the boiler had arrived to redness, had attained a high temperature, was cooled afterwards to below 100°, when the boiler had reached the temperature of redness, although in this case there had not been any notable loss of steam. After a great number of other experiments, M. Lechevalier concluded, that the temperature of water, heated in an incandescent vessel is always less than 100°; that, accordingly, the principle of the equilibrium of temperature in a confined space, which has heretofore been considered as fundamental in the theory of heat, cannot any longer be admitted; and that this principle is liable to exceptions in particular cases.—*Revue Médicale, Sept.* 1830.

12. *The conversion of magnetism into electricity.*—This long wished for result has at length been obtained by Mr. Faraday. If two wires, A and B, be placed side by side, but not in contact, and a voltaic current be passed through A, there is instantly a current produced, by induction, in B, in the opposite direction. Although the principal current in A be continued, still the secondary current in B is not found to accompany it; for it ceases after the first moment; but when the principal current is stopped, then there is a second current produced in B, in the opposite direction to that of the first, produced by the inductive action, or in the same direction as that of the principal current. These induced currents are so momentary that their effect on the galvanometer is scarcely sensible; but when they are passed through helices containing unmagnetized steel needles, they convert them into magnets.

If a wire, connected at both extremities with a galvanometer, be coiled, in the form of a helix, round a magnet, *no current* of electricity takes place in it. This is an experiment which has been made hundreds of times by various persons, in the hope of evolving electricity from magnetism. But if the magnet be withdrawn, or introduced into such a helix, a current of electricity is produced *whilst the magnet is in motion*, and is rendered evident by the deflection of the galvanometer. If a single wire be passed by a magnetic pole, a current of electricity is induced through it, which can be rendered sensible. Whenever, also a piece of metal moves near a magnet, so as to intersect the magnetic curves, electricity is evolved, according to very simple laws.—*Phil. Mag. April*, 1832.

13. *New lamp.*—In the course of the first meeting, at York, of the British association for the advancement of science, the Rev. Wm. V. Harcourt showed a lamp constructed on a new principle, and explained the principle and construction of it. He gave it the name of an *oil gas lamp;* not because it was lighted by gas formed at a temperature below that of flame (for this is common to all lamps) but because, as in the gas lights of the streets, the gas issues from a reservoir, and owes the perfection of its combustion not to an ascending current of hot air, but to the force with which it is propelled from the reservoir and carries the air along with it. It differed, however, from the common gas lights in these circumstances:—that the reservoir formed part of the burner; that the gas was formed as it was consumed; and that it was propelled not by a *vis a tergo*, and in a state of condensation, but by the expansive force of its own heat. In consequence of this circumstance, the current of the gaseous jet was more rapid in proportion to the quantity of water contained in it than in the common gas light, whilst it was also at a much higher temperature, so that it could issue with a greater velocity without being liable to blow itself out. The practical difficulty consisted in the obtaining a steady supply of light, especially with the cheap oils. This difficulty had been in a great measure surmounted; but the instrument was still imperfect.—*Idem.*

14. *Pelokonite, a new mineral.*—Its name comes from πελὸς, brown, and κόνις, dust, in allusion to the color of its streak. Form unknown; cleavage none; fracture conchoidal; color bluish-black; streak liver-brown; opake; lustre vitreous, feeble; tenacity not great; hardness 3·0; sp. gr. 2·50—2·56. It is very soluble in muriatic acid,—the solution having a pistachio green color. It is found in the Terra Amarilla and the Remolinos, in Chili, along with copper green malachite, and another unknown blackish-brown mineral with a yellow streak. The above description is by Richter, of Freyberg.—*Jameson's Journal.*

15. Soda Alum of Milo, a sulphate of alumine.—In the *Arsberättelse om framstegen I Physik och Chemie afgifven den* 31

mars 1830, by Berzelius, allusion is made to my examination of the Native Alum of Milo, (a notice of which appeared in Vol: XVI of this Journal) in which, in consequence of having detected in it the existence of soda, and from the consideration of its natural historical properties, I suggested that it was identical with the Native Soda Alum described by Dr. Thomson, of Glasgow, in the Annals of the Lyceum of Natural History of New York, Vol. III, p. 19,—not presuming to decide whether that mineral constituted a distinct species; and still less, was I "misled" in adopting the opinion, as Berzelius supposes, that it was identical with the artificial soda alum,—an opinion attributed to Dr. Thomson also, but which I think is erroneously inferred from his language. Dr. Thomson has, however, obviously committed an oversight in stating the only difference between the native and the artificial soda alum to consist in this, that the former contains only twenty atoms of water, while the latter contains twenty five atoms, since besides the disagreement in crystalline form, of which he afterwards speaks, the difference alluded to by Berzelius of the rapid efflorescence of the artificial soda alum, and the absence of this property in the native mineral, undoubtedly exists.

It appears, however, from the account of Berzelius, that the so called Milo Alum has since been subjected to a quantitative analysis. "On the return of Mr. Berggren from his travels in Turkey and Greece, he submitted to the Royal Academy, a specimen of this salt from Pyromeni (in Milo); which, before it was deposited in the collection, was analyzed by Hartwall, and was found to contain

Sulphuric acid,	40.31
Alumine,	14.98
Potash,	0.26
Soda,	1.13
Magnesia,	0.85
Muriatic acid,	0.40
Silica,	1.13
Water,	40.94
Traces of oxide of iron, oxide of copper and ammonia.	
	100.00

From whence it clearly appears, that the mineral is a native crystallized sulphate of alumine, containing an accidental portion of potash and soda alum, of sulphate of magnesia, sulphate of iron and sulphate of copper."

From the foregoing, it is obvious, that the Milo mineral is not a true alum, as was formerly supposed, but a sulphate of alumine; and whether it be identical with the South American alum, described by Dr. Thomson, there remains nothing but an apparent coincidence of external properties to prove.

16. *Datholite and Iolite in Connecticut.*—My attention was called a few weeks ago, by Mr. J. D. Dana, of the Junior Class in Yale College, to a small geode of beautifully transparent crystals imbedded in trap, collected by him at a spot, near the village of Middlefield, called Middletown falls. He was conducted thither by some of his acquaintance in Middletown, to whom the locality was known, and by whom the mineral was regarded as Quartz, or Chabasie. Mr. Dana however, was satisfied as well from its form as its hardness, that it could not belong to the former of these species, and was doubtful of its identity with the latter.

By an experiment, I immediately satisfied myself that its hardness was between 5. and 5.5; and therefore too high for Chabasie. Its crystals also, though small and highly complicated, were seen obviously to belong to a prismatic system of crystallization. A few of the angles were ascertained by means of the reflective goniometer, and a perfect coincidence with the angles of Humboldtite of Levy, (now known to be Datholite) was detected. The mineral appeared to me so interesting, no less on account of the modifications of its crystals than for the reason that we have long since ceased to obtain specimens of Datholite from Patterson, New Jersey, that I was immediately induced to visit the spot.

The falls themselves would have compensated for the visit, constituting as they do, a beautiful object of picturesque scenery. The stream where it precipitates itself over the trap, is apparently two rods wide; and when not unusually swollen, two or three feet in depth. I was informed that the height of the fall is thirty feet. When viewed from below, it presents a flat surface of unbroken foam from top to bottom;—the face of the rock over which the stream passes being rough and not perpendicular, but rather making an angle of twenty or twenty five degrees with a line vertical to the plane of the horizon. The trap upon either side of the river, mounts somewhat higher, especially upon the eastern side, where it offers to the spectator who is at the foot of the falls upon the opposite bank, an overhanging aspect. A profusion of trees and shrubs, moreover, clothe the tops of the rocks, and the borders of the stream below the falls,—imparting to the place in a high degree, the effect of seclusion. When the river is swollen by the spring freshets, the noise of the waterfall is heard to the distance of several miles.

The trap wherever it comes into view, presents numerous empty cavities, some of which are an inch or two in diameter. By breaking into the rock, a little way from its surface, these cavities are found, still occupied with the Datholite and other imbedded minerals. But specimens are procured more conveniently from among the largest fragments of the trap which surround the base of the hills directly below the falls. The Datholite forms seams and amygdaloidal masses, varying from one inch to two inches in length. These seams and masses are either wholly composed of the mineral, or have within, cavities of larger or smaller dimensions. In the former case, the mass is fibrous or granular,—the two varieties never occurring together, but the whole mass is either made up of delicate, radiating fibres or composed of fine granular individuals. Where a cavity is found within the mass, its walls are lined with the most brilliant crystals which surmount, or are situated upon, the internal extremities of the fibres. These crystals are completely transparent and colorless, or are translucent with a faint tinge of yellow or green.

This locality is rendered the more interesting, inasmuch as it presents us with the connexion among what was formerly considered as forming three distinct species: viz. Humboldite, Datholite and Botryolite. For its crystals give the principal measurements of the two first mentioned substances; and the fibrous, semi-botryoidal properties which it manifests in other specimens, show its relation to Botryolite.

It deserves to be farther remarked in description of the fibrous variety afforded by this locality, that the fibres where they commence radiating from the exterior of the mass and where they are in juxtaposition with the trap, are sometimes of a pale, flesh-red color: at others, they are milk white; and so close is the aggregation of the individuals, that the naked eye can with difficulty detect the fibrous texture.

The hollow masses of Datholite contain occasionally, a transparent bluish Selenite; and also a bluish Calcareous Spar, which is sometimes in regular crystals of the cuboid form and constitutes apparently, the *Prunnerite* of Esmark. Small geodes of Chlorite and of a delicately green Prehnite exist also in the same rock, but the Datholite is never immediately associated with any other substance than the one above mentioned.

The *Iolite* is found at Haddam. I was accidentally made acquainted with the fact during a visit to the Chrysoberyl locality, which I made early the present season. The quarryman whom I employed brought to me, just as I was leaving the place, a piece of a rock, which he informed me had been blasted the year before, on account of a dark fibrous mineral it contained. The substance to which he referred was obviously Anthophyllite; but along with it, I recognized handsome, violet-blue Iolite. Having ascertained the spot where it was obtained, I determined to visit it on the first convenient occasion, which proved to be during my excursion to Middlefield; from which place, it is twelve miles distant.

The Iolite locality exists upon the high ground directly west of the Court House, in Haddam, distant from it only about seventy rods, and situated in a somewhat open space, near the meeting of four roads. The mineral occurs in gneiss, which here puts on the aspect of mica-slate. It forms in some places one third of the rock. It rarely, however, presents masses above one inch in diameter; and is intermingled with Quartz, Feldspar, Mica, Garnet, Anthophyllite, Talc and Octahedral Iron. Its color is a rich violet blue, sometimes approaching sapphire-blue. It is transparent or translucent, imperfectly foliated in one direction, and exhibits the property of dichroism.

Before concluding this notice, I ought to mention that Lieut. Mather has recently informed me that having collected several specimens of the Anthophyllite last year at this place, he afterwards recognised the mineral above described in connexion with them.

C. U. Shepard.

New Haven, July 1, 1832.

OTHER NOTICES.

1. *Notice of Eaton's Geological Text Book, second edition, 8vo., pp.* 140. *Published by Messrs. Carvill, New York, Websters & Skinners, Albany, and Wm. S. Parker, Troy*, 1832.—The subject matter of this treatise has been published six times before the present edition. 1st in 1818 and 2d in 1820, under the title Index to the Geology of the Northern States; 3d in 1824, as the Report of a Geological survey of Erie Canal, taken at the expense of the Hon. S. Van Rensselaer; 4th as a Geological Nomenclature; 5th as a Prodromus, presenting a new view of classification of rocks by series and formations; 6th as a Geological Text Book in 1830. Now (1832) it appears as a second edition of the last.

We shall notice nothing more than the most important alterations from the edition of 1830.

1. Ten pages are devoted to the progress of Geology in America. In this the author professes to confine himself, chiefly, "to that field where he has been a continual laborer."

2. Twenty two pages are occupied with descriptions of organized remains, and sixty eight lithographic figures are inserted, to represent the most common species, which he has personally examined *in situ.*

3. The author confesses, that Dr. Morton has demonstrated that the Marl beds of New Jersey are the genuine chloritic chalk of Brongniart; but treats them as alternations with Tertiary clays.

4. The red sandstone group of De La Beche, he says, appears to be equivalent to his saliferous, ferriferous, liasoid, and geodiferous rocks; which he treats as subordinates.

5. Near the end of the book, he gives an alphabetical list of localities; and he solicits materials for extending it, in another edition. His references to localities are much extended. Whether we agree or disagree with Mr. Eaton in his speculative views, his collection of facts, and very particular local references, are important contributions to the general stock of geological knowledge.

2. *Rational expressions for sines, tangents and secants;* by David Gould.—The following expressions have some peculiar properties, which, it is presumed, will entitle them to a place in the Journal of Science, if they have not been before published.

Let r be the radius of a circle, φ, an arc of the same, n and p, other quantities either known or unknown, and let

$$\text{sine (of } \varphi) = 2\ r\ n\ p \div (n^2+p^2);$$

then, $(\text{rad.}^2 - \text{sin.}^2)^{\frac{1}{2}} =$

$$(r^2 - (2rnp)^2 \div (n^2+p^2)^2)^{\frac{1}{2}} = \text{cos.} = r(n^2-p^2) \div (n^2+p^2),$$

rad. $^2 \div$ sin. $=$

$$r^2 \div (2nrp \div (n^2+p^2)) = \text{cosec.} = r(n^2+p^2) \div 2np,$$

rad.$^2 \div$ cos. $=$

$$r^2 \div (r(n^2-p^2) \div (n^2+p^2)) = \text{secant} = r(n^2+p^2) \div (n^2-p^2),$$

rad. $\times$ sin. $\div$ cos. $=$

$$(r \times 2rnp \div (n^2+p^2)) \div (r(n^2-p^2) \div (n^2+p^2)) = \text{tan.} = 2\ r\ n\ p \div (n^2-p^2),$$

rad.$^2 \div$ tan. $=$

$$r^2 \div (2rnp \div (n^2-p^2)) = \text{cotan.} = r(n^2-p^2) \div 2np.$$

And by the well known series,
tan. − tan.^{3}÷3+tan.^{5}÷5 − tan.^{7}÷7+ &c. = the corresponding arc, we have $2rnp \div (n^2-p^2)-(2rnp)^3 \div 3(n^2-p^2)^3+(2rnp)^5 \div (n^2-p^2)^5$ — &c.$=\varphi$.

Observations.—1st. If $n=p$, then φ=one quadrant. If n or $p=0$, then $\varphi=0$. 2d. If $n>p$, then the functions of φ, indicated by the expressions are all positive quantities. If $p>n$, then the cosine, secant, tangent and cotangent will be negative quantities. In this case $r(n^2-p^2)=q$ is an absurd and impossible expression, but we may put $r(n^2-p^2) \div (n^2+p^2)=-q$. So also of the other functions enumerated. 3d. When a sine, tangent or secant of φ, or its complement$=a$, the values of two of the quantities which enter into the expressions, viz. of r, n or p, may be assigned arbitrarily, within certain limits, $=b$, c or d, and, the other being $=x$, may be found by an equation not exceeding a quadratic, and if the conditions the last observation be preserved, there will be no imaginary expression. 4th. The expressions for the sine, tangent and secant of φ, and its complement are each comprised in a finite and small number of terms, *which have no radical or surd quantities.* If the value of any one of these functions be assumed equal to a given quantity, then indeed, the value of one of the quantities may be inexpressible in numbers except by an infinite series, or a radical quantity, but the general analytical expression will always be entirely free from radicals. 5th. The expressions cannot possibly transcend the limits of the values of the functions they represent. Thus it is impossible to make $2rnp \div (n^2+p^2)>r$, or $r(n^2-p^2) \div (n^2+p^2)>r$, or $r(n^2+p^2) \div 2np<r$, or $r(n^2+p^2) \div (n^2-p^2)<r$. 6th. Putting $r^2=a^2$, the expressions give a formula for finding two numbers, the sum or difference of whose squares is equal to the square of a given number. For sec.^{2} − tan.^{2}=rad.^{2}, and sin.^{2}+cos.^{2}=rad.^{2}. 7th. The arbitrary quantities, mentioned in observation 3d, may be used for the purpose of making the expressions conformable to any two possible conditions in addition to those there mentioned.

Queries.—1st. May not the expressions given in this article be used in some analytical investigations respecting the circle and its functions in preference to those generally adopted? 2d. Is it possible by any modifications of these expressions to represent the relation of φ to its common functions in a limited number of terms?

3. *Abstract of Meteorological Observations,* made at Middletown, Monmouth Co., N. J.,* Lat. 40° 26′ N., Long. 73° 59′ W., from May 31st, 1831, to June 1st, 1832; by John F. Jenkins, Principal of the Middletown Academy.

1831 and 1832.	Thermometer.											Weather.					Winds.								Miscell's.		
					Maximum of temperature.			Minimum of temperature.				No. of days of different variation.															
Months.	Mean temperature at sun rise.	Mean temperature at 2 P. M.	Mean temperature at 9 P. M.	Average each month.	Day.	Hour.	Highest deg.	Day.	Hour.	Lowest deg.	Range of therm'r.	Fair.	Cloudy.	Rainy.	Showers.	Snow & hail.	N.	N. E.	E.	S. E.	S.	S. W.	W.	N. W.	Thunder.	Inches of snow.	Inches of rain.
June,	63.6	70.	64.5	66.	2	3 P. M.	92	24	4 A. M.	45	47°	23	7	4	7	—	—	4	4	4	6	10	2	—	8	—	4.1
July,	67.3	74.9	69.5	70.5	31	3 "	88	7	5 "	55	33	25	6	3	8	—	—	4	1	4	2	10	7	3	6	—	3.4
August,	73.5	79.6	74.7	75.9	17	4 "	89	29	5 "	62	27	22	9	2	9	—	1	5	2	1	2	10	7	3	7	—	1.7
Sept.	64.6	70.1	67.	67.2	10	2 "	85	30	6 "	53	32	19	11	3	5	—	2	7	1	2	2	8	8	—	2	—	2.5
October,	54.6	64.3	58.2	59.	4	2 "	77	29	6 "	44	33	24	7	4	2	—	—	3	—	7	5	6	4	6	—	—	4.0
Nov.	41.7	49.	44.5	45.	11	3 "	66	30	7 "	28	38	22	8	1	3	2	1	2	—	2	2	3	8	12	2	.3	3.1
Dec.	25.	30.4	27.1	27.5	24	11 A. M.	44	16	7 "	12	32	18	13	1	1	10	1	4	—	—	1	3	11	11	—	10.7	.3
January,	32.8	39.5	34.4	35.5	19	3 P. M.	62	28	7 "	2	60	21	10	3	3	5	1	5	—	1	2	4	9	9	—	5.2	5.2
Feb.	36.	40.5	39.2	38.5	19	2 "	64	24	6 "	20	40	12	17	0	10	8	1	9	1	3	1	5	3	6	—	5.5	2.0
March,	40.5	50.2	41.6	44.1	12	3 "	71	18	6 "	19	52	23	8	2	4	1	—	2	—	3	5	10	2	9	1	.5	1.1
April,	46.8	56.7	51.6	51.3	26	3 "	81	7	5 "	33	45	18	12	6	5	—	—	8	6	2	—	6	4	4	2	—	2.5
May.	55.	64.3	57.6	59.	14	3 "	77	25	5 "	46	31	17	14	4	4	—	1	4	1	9	3	3	5	3	2	—	4.5
Agg. tem.	50.1	57.4	52.5	53.3	*Recapitulation.*							244	122	33	61	26	8	57	16	38	31	80	70	66	30	22.2	34.4

* The observations were carefully made, and the thermometer placed in a fair exposure, in the shade, but communicating freely with the external air.

Remarks.—The mean temperature of the year was 53.3°; heat greatest in August and least in December. The warmest week, however, was the first in June, and the coldest day in January.

The temperature of May and October was the same. The greatest range of the thermometer in any one month was 60° in January, and the least 27° in August. Whole range during the year 90°. The minimum of temperature here was considerably higher than in some places at the south and west. At Nashville, Tenn. the minimum was 18° below zero, while with us it was 2° above, and only 4° lower than in the preceding winter.

This spring has been unusually cold. Vegetation is generally backward, and garden plants have been several times injured by frost in May, and even as late as the 27th. While I am writing, (June 1st,) the thermometer stands at 54°; last year, on this day, it was at 90°.

No occurrence of the Aurora Borealis was observed during the year.

Under *showers*, I have noticed those days on which rain fell but a small part of the time; some of which are, of course, marked under *cloudy*, and others under *fair*.

4. Treatise on Mineralogy; by Charles Upham Shepard, *Lecturer on Botany in Yale College; Member of the American Geological Society; Corresponding Member of the Academy of Natural Sciences of Philadelphia, &c.* New Haven: H. Howe, 1832.— The above named work, partly on the plan of Prof. Mohs, and partly original, treats of Mineralogy as an independent science, separating from it a variety of information formerly regarded as belonging to it; and presents the scientific departments of which it consists distinctly, in strict conformity with the method according to which the other branches of Natural History are treated. The way in which the science has heretofore been treated among us, has obviously lacked the convenience and the precision of its sister sciences Botany and Zoology. A great variety of unconnected information relating to minerals has been presented together, much of which belongs to other sciences; the effect of which was to prevent a clear conception of Mineralogy, and to render inapparent its relation to other branches of knowledge. Its departments were either not distinguished at all, or were more or less involved. The idea of the species, especially, was not fixed; and if the characteristic and description were not entirely blended together, yet the essential characters did not extend to the exclusion of above three or four species. For these reasons, it is well known that the cultivators of other branches of Natural History

have often been disposed to question the propriety of denominating the study of minerals, a science; and we are acquainted with Botanists who have actually abandoned it on the ground that its species were indefinite, and that no scientific characters existed for their recognition.

We give the following as an outline of Mr. Shepard's work.

He treats the science in five parts, under the following general heads; viz. Terminology, Classification, Nomenclature, Characteristic and Physiography.

Part I. or Terminology, embraces an explanation of the natural properties of minerals, or those which they exhibit while in their natural state. These are considered under three divisions; viz. 1, such as refer to simple minerals; 2, such as refer to compound minerals; 3, such as are common to both. The first of these divisions, to which a section of seventy one pages is devoted, embraces the geometrical properties of minerals, or such as refer to space,—the relations of structure, of surface, and the phenomena of double refraction. In treating of the geometrical properties, or what is more usually understood as constituting the science of crystallography, the following order is pursued. To adapt the work to persons ignorant of solid geometry, a few pages are devoted to elementary definitions in that branch. The following propositions are then laid down and illustrated; viz. "1. *Certain mineral species affect peculiar forms*,"—2. "*Several different forms are frequently found in different individuals of the same species*,"—3. "*The different crystalline forms belonging to each species may be conceived to be derived by certain laws from one type or fundamental form.*" The number of such primary forms in the mineral kingdom is then announced; and each of them is described and illustrated in its principal geometrical properties. To this succeeds the consideration of those symmetrical modifications which these forms undergo from the replacements of their edges and angles, and the new figures which are produced when the replacements extend so far as to extinguish the faces of the primary form.

The imperfections of crystals in respect to their forms is next treated of, and the methods employed for ascertaining the angles of crystals. Then follows an account of the internal structure of crystals, or the laws of cleavage. Here the author has deviated from the practice of most writers on elementary mineralogy, in having passed over in silence the subject of the origin of crystals through the aggregation of molecules of a particular shape; a subject, which however curious it may be in general Physics, is nevertheless purely hypothetical, and destitute of any bearing whatsoever, upon determinative or descriptive Mineralogy.

The relations between the forms of cleavage and crystals, and the identity of the former with the primary forms of the species, are then pointed out, and practical rules are given for ascertaining the primary forms of crystals in all cases. The section concludes with a description of the kinds of fracture and surface observable among crystals.

The second section, which relates to compound minerals, commences with an account of regular composition, or the subject of *twin-crystals;* after which, irregular composition in all its varieties is considered under the following heads:—Group and Geode of crystals—Imitative shapes originating in the groups of crystals—Imitative shapes arising out of the geodes of crystals—Amorphous composition—Accidental imitative shapes—Pseudomorphoses—Irregular accidental imitative shapes,—concluding with a description of the varieties exhibited among the particles of composition, a description of single and multiple composition, and the kinds of fracture in compound minerals.

Section 3rd. relates to the Natural Properties belonging both to simple and to compound minerals, and which are divided into Optical and Physical; the former referring more particularly to the mass of minerals, and the latter to their substance. The first consist of lustre, color and transparency; the second, of the state of aggregation, hardness, specific gravity, magnetism, electricity, taste and odor. Each of these heads is treated with the requisite degree of particularity, but not so as to require any notice here, excepting the property of Hardness. This is illustrated according to the plan of Mohs, and with considerable minuteness, it being a property that ranks next to crystalline form in the determination of minerals. A scale is established for ascertaining the degrees of hardness, by selecting a certain number of suitable minerals, of which every preceding one is scratched by that which follows it, while the former does not scratch the latter; and the degrees of hardness are expressed by numbers, prefixed to the different individuals of the scale.

Part II. which consists of the classification, contains the theoretical part of the science. It fixes the idea of the species, and treats of the princples of classification. After a brief explanation of the two methods of classification, the natural and the artificial—or the synthetical and the analytical, the author introduces his artificial method by the following remarks.

"The first object with the student in Mineralogy being the names of minerals, it becomes necessary to point out with as much clearness as possible the course he must adopt. The most obvious method, and indeed the one which has hitherto been most in practice among learners, is to derive them from a living Instructor; but this being out of the reach of many persons, who would otherwise be glad to form some acquaintance with the mineral kingdom, and where enjoyed, being without any certain mode of verification, is exceedingly unsatisfactory. The second thought is to have recourse to books containing descriptions of every species; but the number has now become so great, that the labor of reading them over in succession, in order to assure ourselves of a single mineral, is too great to be encountered without considerable fatigue and loss of time, and consequently, danger of disgust. An analytical method, therefore, whose sole object is, to lead us, by an easy and sure manner, to the names of minerals, becomes desirable. Its utility in the vegetable kingdom has been abundantly tested; and the only question to be decided is, what shall become of the grounds of our divisions in the mineral kingdom, in order to apply to it the same benefit.

"If we except the synthetical method of Prof. Mohs, no system is to be found in which the requisite assistance, above alluded to, is afforded. If, for example, we bestow a few moments attention upon the arrangement of the Abbé Haüy, the most celebrated hitherto constructed, and which has been made the basis of several popular treatises upon the science, we shall find it incapable of accomplishing this end. It is true, it contains classes, orders and genera; but surely, neither their author nor any other person, ever supposed it possible, that the learner could derive advantage from them in the way in which a botanist does from similar ideas in the determination of an unknown plant; viz. by first ascertaining its class, then the order, then the genus, and lastly, by reading over the essential differences among the unities within this last general idea, to arrive at the appropriate species. Now, who avails himself of this method as respects the classification of Haüy? Who analyzes a mineral to determine its class, order and genus, with a view of arriving at its name? No one certainly. It might be asked, who can do it? for how few are able! Most clearly then, it subserves no utility in the determination of unknown minerals. Its sole merit consists, in providing for the proficient in Mineralogy, one way of arranging the different objects of his knowledge in his cabinet, and the ideas which relate to them, in his mind. This certainly is an object of much importance, but secondary in point of time to the one now under consideration. Our information must first be acquired, before it can be philosophically arranged.

"It is otherwise, however, with respect to the system first mentioned: this provides for the determination of the species in a scientific manner, the learner being enabled to proceed to the names of minerals through the intermediate degrees of the class, order, and genus, without being obliged to read over the entire catalogue of species in each instance, when an unknown mineral is to be determined. But, like the system of Natural Orders in Botany, it experiences frequent embarrassments from those combinations which the principles of the synthetical method impose, and which render it necessary, in order to distinguish the genera within an order, and the species within a genus, to descend to the observation of characters, too nice and minute in their application, for the use of the beginner. To the advanced student, however, this system becomes more available, since it will often be in his power to determine the place of a mineral by analogy, without the minute study of its characters,—an advantage which no purely artificial system can possess. Like the same system in Botany, it is superior to all other methods after a certain amount of knowledge is acquired, but at first, is liable to confuse and discourage."

His classes and orders are formed as follows: "*The mineral kingdom is divisible into three classes; 1. Minerals possessed of regular forms; 2. Minerals yielding regular forms only by cleavage; 3. Minerals destitute of regular forms, and not affording them by cleavage. The first may be termed the Crystallized class, the second the Semi-crystallized class, and the third the Uncrystallized class.*" The two first classes are divided into orders by their different systems of crystallization, or primary forms. The third is divided into three orders, according as its contents are solid, liquid or gaseous. The following remarks respecting these divisions are from the author.

"It may require an explanation, why a mineralogical method should, unlike the systems in Zoology and Botany, make provision for any but perfect or crystallized minerals. In the vegetable kingdom it is well known, that no object is considered as classifiable, unless possessed of the parts of fructification; or, in other words, of the highest degree of perfection, in its characters, under which it is capable of appearing. And although the majority of plants, ordinarily under our observation, is imperfect in these respects, no serious inconvenience arises from the fact, since they are all possessed of an active principle, whose operation will at length advance them to maturity; in addition to which, we have no difficulty in finding other individuals of the same species, already in possession of the requisite perfection to enable us to accomplish their determination. But it is otherwise in the mineral kingdom. Semi-crystallized and uncrystallized minerals constitute by far the largest part of those requiring determination, and they are wholly destitute of any tendency towards a higher degree of perfection. As we find them, so they remain, (unless, indeed, they become, as sometimes is the case, more imperfect still, from external agencies;) and, unlike the determination of imperfect plants, by the aid of those which are more perfect, it is seldom possible to determine them from their association with crystallized individuals of the same species. From this we see, that a method which should omit to provide for such minerals as are not fully perfect in their characters, would be extremely imperfect in general practice.

"As a consequence of this necessity of providing means for the determination of imperfect minerals, has arisen the frequent division of the species. Thus, portions of the species Fluor are found in all of the classes, according as the individuals are crystallized, cleavable or massive. It is to be remarked, however, that this division within the species, (unknown in the other departments of Natural History,) never takes place in the crystallized individuals of the mineral kingdom; among which only should we expect to find the rule of preserving the species unbroken observed, since they alone correspond to the classifiable objects in Zoology and Botany."

The author farther explains and vindicates his system in the following remarks.

"The present arrangement is not liable to any objection, on the ground that the natural relations among the species have been disregarded, much less that chemical affinities are overlooked. It is to be tested only, as it does, or does not, afford the most direct means in leading to the names of unknown minerals. The properties upon which it is founded are of easy observation and possessed of sufficient constancy: their examination does not involve a knowledge of other sciences, or require an inconvenient minuteness of detail. What is more easy, for example, than to settle whether a mineral be crystallized, and if not, whether it yield a regular solid by cleavage? These are the only questions to be solved in the determination of the class. And if due attention has been paid by the pupil to the section on Crystallography, the orders in the two first classes may be ascertained with nearly the same degree of ease. The system of crystallization, in most cases, is a problem to which the lowest attainments in Mineralogy are adequate; or rather, it is one, which, until the pupil is able to master, he is unprepared to take a single step to advantage in the study of the mineral kingdom. The orders in the remaining class need only to be mentioned, to be recognized."

The arrangement of the species in each order is in a series, depending upon the property of hardness, except in the two last orders of the third class, where it depends upon the property of specific gravity.

"Where the series depends upon the property of hardness, the orders commence with the softest species, and terminate with the hardest: in the other case, it begins with the lightest and terminates with the heaviest.

"Had it promised an additional convenience, in arriving at the names of minerals, through the use of this system, it would have been easy to have divided the orders into genera, depending upon fixed degrees of hardness and specific gravity. The idea of a series within the genus, however, founded upon these properties, seemed preferable, inasmuch as it possesses every possible facility which would attend the division in question, besides the advantage of rendering the arrangement considerably less complicated, both as respects the nomenclature and practice."

Part III. explains the object of nomenclature in general, and of systematic and trivial nomenclature in particular; and it is stated for the following reasons that the nomenclature in an analytical system must be a trivial one.

"In an analytical system, we must not look for similarity among the species of any one class or order; to name the species in such a manner as to suggest the class and order to which they individually belong, instead of serving to illustrate or simplify the general survey of the mineral kingdom, would only produce confusion. A designation, therefore, wholly irrespective of any such relations should be employed. All that we demand of nomenclature, so far as the analytical method is concerned, is the simplest designation of the object possible, from which we may be pointed forward to the descriptions for the remaining information of which we are in search; we have no interest in being carried back to the artificial ideas by whose means we have accomplished this preliminary step.

"It is true, provided the names employed in the analytical method do not lead us back to the orders and classes of that method, it would not be very objectionable what denominations were employed, whether those of the systematic nomenclature, or the chemical names, so far as minerals are possessed of them; yet, as the object of this method is only a preliminary step, those which are the shortest and most convenient seem preferable, and these are the trivial names.

"At the same time, care has been taken to give, in a smaller type, the systematic names of Mohs, and some of the important synonyms of other authors, in order to enable the student to refer with convenience, to the general descriptions in different works upon the science."

Part IV. consists of the characteristic, whose province in Natural History it is, to furnish the peculiar marks by which we can distinguish objects from each other, so far as they are comprehended in the ideas established by the theory of the system. This is to be employed only with the mineral in our hand, and instructs us what properties are to be noticed in it, in order that we may be conducted to its name. Is the mineral crystallized? such a property is the character of the class. Is its system of crystallization the cube? such an observation will fix the order. The determination of its degree of hardness will bring it into a group of two or three species; and the experiment for specific gravity will identify it with the species to which it belongs. Or is the unknown mineral destitute of a crystalline structure? such a fact establishes its class, in like manner; and the hardness being settled, the inquirer is led to a group consisting of all known minerals possessed of a similar degree of hardness, and which are arranged in the order of their specific gravities. The specific gravity of the mineral whose name is sought being taken, the observation of one or two other easily observed properties will be sufficient to complete the research.

The characteristic occupies one hundred pages of the treatise. The characters of the species are presented in tables; in which, for the purpose of diminishing the labor of determining American minerals, all such as have hitherto been found in the United States are designated by a particular mark. These tables present us the following interesting result, with respect to the productiveness of our country in this department of Natural History: out of three hundred and fourteen species—the whole number of well settled species contained in the mineral kingdom—we have one hundred and thirty four species; and out of two hundred and twenty two crystallized species, the United States contains ninety five, which sometimes present themselves under regular forms.

These tables will be found worthy of particular attention, as affording the most recent views of the species in Mineralogy. A great number of minerals, which figure under distinct names in mineralogical works are here made to coalesce with other species; while on the other hand several new species of which accounts have appeared only in the recent scientific journals of Europe are here presented for the first time to the English reader.

The natural historical names of Mohs are given as synonyms to the trivial ones, in the characteristic, as well as the chemical designations and those names which were necessary for the purpose of elucidating the new views of mineralogical species, above alluded to.

The nature of physiography—the fifth part in this treatise—is simply explained;—the general descriptions of which it consists being reserved for a future volume, in the preparation of which the preface states the author to be now engaged.

5. *West Chester County Cabinet of Natural Science.*—By the 5th report it appears that the Institution is in a flourishing condition; that its collections in several branches of Natural History particularly Botany, Mineralogy and Conchology are already very considerable and increasing; its herbarium contains about 4000 specimens, 3000 of which are presents from abroad; it has a collection of coins, and a telescope which formerly belonged to General Anthony Wayne, presented by his son, Isaac Wayne, Esq.

The collections of the Society are, from time to time, increased by the public spirit of our naval officers and others who travel abroad. A considerable number of original papers on subjects of Science has been contributed by members of the society.

6. *Destruction of Birds by starvation.*

Extract of a letter to the Editor from S. Woodruff, Esq. dated Windsor, Ct. June 12, 1832.

Among other effects produced here by the late unusually cold weather, it may be thought worthy of notice that swallows and some other small birds which feed principally on flying insects have, in vast numbers, perished by hunger. Between the 6th and 28th days of May, 14 barn swallows were picked up in and about one barn in my neighborhood; and I am credibly informed that at many other barns in the vicinity, from ten to fifteen, in each barn, were found in a like condition. Several hundreds have perished in the single town of Granby. By reason of cold the insects continued in a torpid state, and afforded no opportunity for the birds to come in contact with them.

About the 12th of May (eight days later than their usual period) the martins appeared; but finding little or no food, soon disappeared, and for the twelve or fifteen days following none were seen, and up to the present time but few have returned.

About the 10th of May several flocks of wild geese passed over on their return to the south.

APPENDIX.

On the Production of Currents and Sparks of Electricity from Magnetism; by Prof. J. Henry.

Although the discoveries of Oersted, Arago, Faraday, and others, have placed the intimate connection of electricity and magnetism in a most striking point of view, and although the theory of Ampere has referred all the phenomena of both these departments of science to the same general laws, yet until lately one thing remained to be proved by experiment, in order more fully to establish their identity; namely, the possibility of producing electrical effects from magnetism. It is well known that surprising magnetic results can readily be obtained from electricity, and at first sight it might be supposed that electrical effects could with equal facility be produced from magnetism; but such has not been found to be the case, for although the experiment has often been attempted, it has nearly as often failed.

It early occurred to me, that if galvanic magnets, on my plan, were substituted for ordinary magnets, in researches of this kind, more success might be expected. Besides their great power, these magnets possess other properties, which render them important instruments in the hands of the experimenter; their polarity can be instantaneously reversed, and their magnetism suddenly destroyed or called into full action, according as the occasion may require. With this view, I commenced, last August, the construction of a much larger galvanic magnet than, to my knowledge, had before been attempted, and also made preparations for a series of experiments with it on a large scale, in reference to the production of electricity from magnetism. I was, however, at that time, accidentally interrupted in the prosecution of these experiments, and have not been able since to resume them, until within the last few weeks, and then on a much smaller scale than was at first intended. In the mean time, it has been announced in the 117th number of the Library of Useful Knowledge, that the result so much sought after has at length been found by Mr. Faraday of the Royal Institution. It states that he has established the general fact, that when a piece of metal is moved in any direction, in front of a magnetic pole, electrical currents are developed in the metal, which pass in a direction at right angles to its own motion, and also that the application of this principle affords a complete and satisfactory explanation of the phenomena of magnetic rotation. No detail is given of the experiments, and it is somewhat surprising that results so interesting, and which certainly form a new era in the history of electricity and magnetism, should not have been more fully described before this time in some of the English publications; the only mention I have found of them is the following short account from the Annals of Philosophy for April, under the head of Proceedings of the Royal Institution.

"Feb. 17.—Mr. Faraday gave an account of the first two parts of his researches in electricity; namely, Volta-electric induction and magneto-electric induction. If two wires, A and B, be placed side by side, but not in contact, and a Voltaic current be passed through A, there is instantly a current produced by induction in B, in the opposite direction. Although the principal current in A be continued, still the secondary current in B is not found to accompany it, for it ceases after the first moment, but when the principal current is stopped then there is a second current produced in B, in the opposite direction to that of the first produced by the inductive action, or in the same direction as that of the principal current.

"If a wire, connected at both extremities with a galvanometer, be coiled in the form of a helix around a magnet, no current of electricity takes place in it. This is an experiment which has been made by various persons hundreds of times, in the hope of evolving electricity from magnetism, and as in other cases in which the wishes of the experimenter and the facts are opposed to each other, has given rise to very conflicting conclusions. But if the magnet be withdrawn from or introduced into such a helix, a current of electricity is produced *whilst the magnet is in motion*, and is rendered evident by the deflection of the galvanometer. If a single wire be passed by a magnetic pole, a current of electricity is induced through it which can be rendered sensible."*

Before having any knowledge of the method given in the above account, I had succeeded in producing electrical effects in the following manner, which differs from that employed by Mr. Faraday, and which appears to me to develope some new and interesting facts. A piece of copper wire, about thirty feet long and covered with elastic varnish, was closely coiled around the middle of the soft iron armature of the galvanic magnet, described in Vol. XIX of the American Journal of Science, and which, when excited, will readily

* This extract will also be found on page 386 of this Journal.—*Ed.*

sustain between six hundred and seven hundred pounds. The wire was wound upon itself so as to occupy only about one inch of the length of the armature which is seven inches in all. The armature, thus furnished with the wire, was placed in its proper position across the ends of the galvanic magnet, and there fastened so that no motion could take place. The two projecting ends of the helix were dipped into two cups of mercury, and there connected with a distant galvanometer by means of two copper wires, each about forty feet long. This arrangement being completed, I stationed myself near the galvanometer and directed an assistant at a given word to immerse suddenly, in a vessel of dilute acid, the galvanic battery attached to the magnet. At the instant of immersion, the north end of the needle was deflected 30° to the west, indicating a current of electricity from the helix surrounding the armature. The effect, however, appeared only as a single impulse, for the needle, after a few oscillations, resumed its former undisturbed position in the magnetic meridian, although the galvanic action of the battery, and consequently the magnetic power was still continued. I was, however, much surprised to see the needle suddenly deflected from a state of rest to about 20° to the east, or in a contrary direction when the battery was withdrawn from the acid, and again deflected to the west when it was re-immersed. This operation was repeated many times in succession, and uniformly with the same result, the armature, the whole time, remaining immoveably attached to the poles of the magnet, no motion being required to produce the effect, as it appeared to take place only in consequence of the instantaneous development of the magnetic action in one, and the sudden cessation of it in the other.

This experiment illustrates most strikingly the reciprocal action of the two principles of electricity and magnetism, if indeed it does not establish their absolute identity. In the first place, magnetism is developed in the soft iron of the galvanic magnet by the action of the currents of electricity from the battery, and secondly the armature, rendered magnetic by contact with the poles of the magnet, induces in its turn, currents of electricity in the helix which surrounds it; we have thus as it were electricity converted into magnetism and this magnetism again into electricity.

Another fact was observed which is somewhat interesting in as much as it serves, in some respects, to generalize the phenomena. After the battery had been withdrawn from the acid, and the needle of the galvanometer suffered to come to a state of rest after the resulting deflection, it was again deflected in the same direction by partially detaching the armature from the poles of the magnet to which it continued to adhere from the action of the residual magnetism, and in this way, a series of deflections, all in the same direction, was produced by merely slipping off the armature, by degrees, until the contact was entirely broken. The following extract from the register of the experiments exhibits the relative deflections observed in one experiment of this kind.

At the instant of immersion of the battery,	deflec.	40°	west.
" " " " "	"	18	east.
Armature partially detached,	"	7	east.
Armature entirely detached,	"	12	east.

The effect was reversed in another experiment, in which the needle was turned to the west in a series of deflections by dipping the battery but a small distance into the acid at first and afterwards immersing it by degrees.

From the foregoing facts, it appears that a current of electricity is produced, for an instant, in a helix of copper wire surrounding a piece of soft iron whenever magnetism is induced in the iron; and a current in an opposite direction when the magnetic action ceases; also that an instantaneous current in one or the other direction accompanies every change in the magnetic intensity of the iron.

Since reading the account before given of Mr. Faraday's method of producing electrical currents I have attempted to combine the effects of motion and induction; for this purpose a rod of soft iron ten inches long and one inch and a quarter in diameter, was attached to a common turning lathe, and surrounded with four helices of copper wire in such a manner that it could be suddenly and powerfully magnetized, while in rapid motion, by transmitting galvanic currents through three of the helices; the fourth being connected with the distant galvanometer was intended to transmit the current of induced electricity: all the helices were stationary while the iron rod revolved on its axis within them. From a number of trials in succession, first with the rod in one direction then in the opposite, and next in a state of rest, it was concluded that no perceptible effect was produced on the intensity of the *magneto-electric* current by a rotatory motion of the iron combined with its sudden magnetization.

The same apparatus however furnished the means of measuring separately the relative power of motion and induction in producing electrical currents. The iron rod was first magnetized by currents through the helices attached to the battery and while in this state one of its ends was quickly introduced into the helix connected with the galvanometer; the deflection of the needle, in this case, was seven degrees. The end of the rod was next introduced into the same helix while in its natural state and then suddenly magnetized; the deflection, in this instance amounted to thirty degrees, shewing a great superiority in the method of induction.

The next attempt was to increase the *magneto-electric* effect while the magnetic power remained the same, and in this I was more successful. Two iron rods six inches long and one inch in diameter, were each surrounded by two helices and then placed perpendicularly on the face of the armature, and between it and the poles of the magnet so that each rod formed as it were a prolongation of the poles, and to these the armature adhered when the magnet was excited. With this arrangement, a current from one helix produced a deflection of thirty seven degrees; from two helices both on the same rod fifty two degrees, and from three fifty nine degrees: but when four helices were used, the deflection was only fifty five degrees, and when to these were added the helix of smaller wire around the armature, the deflection was no more than thirty degrees. This result may perhaps have been somewhat affected by the want of proper insulation in the several spires of the helices, it however establishes the fact that an increase in the electric current is produced by using at least two or three helices instead of one. The same principle was applied to another arrangement which seems to afford the maximum of electric development from a given magnetic power; in place of the two pieces of iron and the armature used in the last experiments, the poles of the magnet were connected by a single rod of iron, bent into the form of a horse-shoe, and its extremities filed perfectly flat so as to come in perfect contact with the faces of the poles: around the middle of the arch of this horse-shoe, two strands of copper wire were tightly coiled one over the other. A current from one of these helices deflected the needle one hundred degrees, and when both were used the needle was deflected with such force as to make a complete circuit. But the most surprising effect was produced when instead of passing the current through the long wires to the galvanometer, the opposite ends of the helices were held nearly in contact with each other, and the magnet suddenly excited; in this case a small but vivid spark was seen to pass between the ends of the wires and this effect was repeated as often as the state of intensity of the magnet was changed.

In these experiments the connection of the battery with the wires from the magnet was not formed by soldering, but by two cups of mercury which permitted the galvanic action on the magnet to be instantaneously suspended and the polarity to be changed and rechanged without removing the battery from the acid; a succession of vivid sparks was obtained by rapidly interrupting and forming the communication by means of one of these cups; but the greatest effect was produced when the magnetism was entirely destroyed and instantaneously reproduced by a change of polarity.

It appears from the May No. of the Annals of Philosophy, that I have been anticipated in this experiment of drawing sparks from the magnet by Mr. James D. Forbes of Edinburgh, who obtained a spark* on the 30th of March; my experiments being made during the last two weeks of June. A simple notification of his result is given, without any account of the experiment, which is reserved for a communication to the Royal Society of Edinburgh; my result is therefore entirely independent of his and was undoubtedly obtained by a different process.

I have made several other experiments in relation to the same subject, but which more important duties will not permit me to verify in time for this paper. I may however mention one fact which I have not seen noticed in any work and which appears to me to belong to the same class of phænomena as those before described: it is this; when a small battery is moderately excited by diluted acid and its poles, which must be terminated by cups of mercury, are connected by a copper wire not more than a foot in length, no spark is perceived when the connection is either formed or broken: but if a wire thirty or forty feet long be used, instead of the short wire, though no spark will be perceptible when the connection is made, yet when it is broken by drawing one end of the wire from its cup of mercury a vivid spark is produced. If the action of the battery be very intense, a spark will be given by the short wire; in this case it is only necessary to wait a few minutes until the action partially subsides and until no more sparks are given from the short wire; if the long wire be now substituted a spark will again be obtained. The effect appears somewhat increased by coiling the wire into a helix; it seems also to depend in some measure on the length and thickness of the wire; I can account for these phænomena only by supposing the long wire to become charged with electricity which by its reaction on itself projects a spark when the connection is broken.

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* From a natural magnet.

*Notice of Electro-Magnetic Experiments.**

[Communicated by Prof. A. D. Bache, of the University of Pennsylvania.]

TO THE COMMITTEE ON PUBLICATIONS.

Gentlemen,—I send you a description of the apparatus for producing the spark from a magnet according to the method of Nobili, and for other recent and curious experiments on electro-magnetism, together with an account of their repetition. This is done that any one who may be desirous to repeat or to extend the experiments may, without delay, be put in possession of the means of so doing.

Extract of a letter from J. Saxton, of Philadelphia, to Isaiah Lukens, dated London, April 14th, 1832.

"You may have heard of Faraday's curious discovery in electro-magnetism. He has succeeded in obtaining from a magnet a spark resembling the electric spark. The apparatus consisted of a copper plate mounted on an axis, like an electrical machine, and made to revolve between the poles of a large magnet. The plate used was about one foot in diameter, and one-eighth of an inch in thickness. The rim of the wheel was amalgamated, as well as a ring around the axis. Two pieces of copper, shaped to fit, for two or three inches, the amalgamated ring and the circle, were attached to either wire of a galvanometer. These pieces of copper being applied to the wheel, and the latter turned, the needle of the galvanometer vibrates: the amount of vibration may be increased by alternately touching and removing one of the plates. The copper plate which touches the rim should be between the poles of the magnet.

"I have made this experiment in a different way and succeeded satisfactorily. The method was as follows. A coil of wire wrapped with silk, similar to that used in the galvanometer, was attached by the ends to the wires of the galvanometer. On passing this roll backward and forward upon one of the poles of a horse-shoe magnet, or placing it upon and removing it from either pole, I have made the needle of the galvanometer spin round rapidly."

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* Communicated in a proof for this Journal, with permission of the committee of publication, of the Journal of the Franklin Institute, by Prof. A. D. Bache of Philadelphia.

Extract of a second letter from J. Saxton, of Philadelphia, to Isaiah Lukens, dated London, May 11, 1832.

"Since my last I have heard of a method of producing a spark from a magnet, discovered, I believe, by an Italian. This experiment I made at once upon a large horse-shoe magnet which I am making for Perkins and his partners. One of your large magnets will answer the same purpose. Make a cylinder of soft iron of an inch or three fourths of an inch in diameter, and of the usual length of the keeper; place two disks of brass or wood upon this cylinder, and at such a distance apart that they will conveniently pass between the poles of the magnet; between these, wind, say fifty feet of bobbin wire, which may be of iron covered with cotton; let the ends of this coil be bent over the ends of the cylinder and brought down until they touch the poles of the magnet, the ends should be of such a a length that on bringing the cylinder to the magnet, one of the ends will touch when the cylinder is about half an inch from the magnet, and the other at one fourth of an inch. The cylinder being thus arranged, and in contact with the magnet, on drawing it suddenly away a spark will pass between the end of the wire and the pole of the magnet."

The apparatus alluded to in these letters was, soon after their receipt, put together by Messrs. Isaiah Lukens and Benjamin Say; it is figured in the cuts which follow.

Fig. 1.

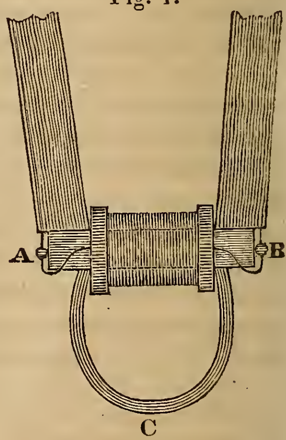


Fig. 1 represents the apparatus of Nobili for procuring the spark from a magnet. A, B, is a cylinder of soft iron; upon this are two brass rims, between which bobbin wire (wrapped wire of iron and copper were both successfully used,) is wound; the ends of the wire coil are carried out at the opposite ends of the cylinder, and being bent downwards, pass through holes in two brass (or wooden) pins. The spring of the wire causes both the ends to touch the magnet when the keeper is attached; when it is withdrawn one end projects beyond the other.*

This apparatus has been improved by

* This condition appears by subsequent experiment to be by no means essential.

Mr. Lukens, by coiling the ends of the wire into a spiral, thus forming a spring to press the points of the wire against the poles of the magnet; and by carefully insulating the ends in their passage through the brass stems.

From this improved apparatus a spark can be obtained on *removing* the keeper with seldom a case of failure; frequently two sparks appear, one at each end of the wire, and in some experiments of Messrs. Lukens and Say a third spark was seen to pass from one of the brass rings. I have very frequently obtained sparks also by rapidly *replacing* the keeper.

To ascertain the nature of this spark, I endeavored to determine whether the removal of the keeper which produces the spark was attended with any electrical effect which would warrant the supposition that this was an electric spark.

The cylindrical keeper, arranged as at first described, was used for this purpose. The ends of the wire spoken of as touching the poles of the magnet were bent outwards, to remove them from the poles, and connected with the wires of a galvanometer. On approaching the keeper to, or drawing it from the magnet, an agitation of the needle of the galvanometer was produced, demonstrating the existence of a current of galvanic electricity, to which, therefore, the spark is probably due.

A few turns, say four or five of iron bonnet wire about the keeper of a magnet, which supported, by a contact with its whole surface, fifty pounds, produced a very sensible vibration in the needle; the contact and removal being made at times tending to increase the arc.

In the experiments of M M. Nobili and Antinori, the account of which has been received since those which I have described were made, it seems that this development of a galvanic current which they observed led them first to suspect that the spark might be obtained.

The following observations were made at the same time with those above described, on the direction of the galvanic current. The needle of the galvanometer used, was suspended by a fibre of silk; upon the stand of the instrument were two brass cups in the same plane with the coils of the wire surrounding the needle; in the cup corresponding to the south pole of the needle, the wire passing from south to north *above* the needle, and from north to south below, was placed; into the north cup was inserted the opposite wire. Thus arranged a current of galvanism passing from south to north will deflect the north pole of the needle to the west; by a current passing from north to south, the north pole of the needle will be deflected to the east. The galvanometer was covered by a glass receiver to prevent agitation from currents of air. The magnet used was the one alluded to above as supporting fifty pounds, this is a horse-shoe magnet, made of ten magnetic bars, the keeper being filed off in front applied itself to two of these.

The magnet being placed with its poles to the south, (the north pole being westward) the keeper was brought to the magnet in such a position that the coil was directed *above* the cylinder from *north to south; below* from *south to north*, the wire from the *upper side* was dipped into the mercury of the *south* cup of the galvanometer, the wire from the *under* side into the *north* cup.

On drawing the keeper from the magnet, the north pole of the needle of the galvanometer passed to the west; the needle being allowed to return to the meridian, a return of the keeper to the magnet deflected the north pole to the east. By assisting the needle in its vibrations by the alternate withdrawal and return of the keeper, a very considerable vibration was produced.

By changing the keeper from right to left so that the wire passing *over* the cylinder was directed from *south to north*, the communications with the galvanometer remaining as before, the reverse of the deflections just described took place.

The effects described may be represented by a galvanic current circulating around the keeper, and at right angles to its axis, directed from north to south above the cylinder when the keeper was withdrawn, in the contrary direction when it was returned. Such a current would evidently have passed out of the upper wire on the withdrawal of the keeper, and out of the under wire on its return; that is, would have passed from south to north, above the needle of the galvanometer, in the first case, and from north to south in the second.

Fig. 2.

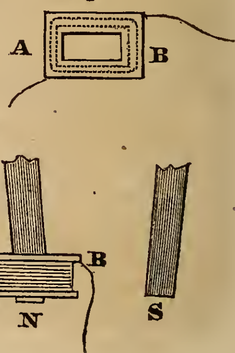


Fig. 2 shows the apparatus for producing vibration in the needle of the galvanometer by the wire coil and magnet. A, B, is a roll of wrapped wire wound about a wooden spool, which has the central part removed; the ends of the wire are connected with the wires of a galvanometer; this roll is represented in the lower part of the figure as placed upon the north pole of a horse-shoe magnet, by passing it to and fro upon the leg of the magnet, or by alternately removing and replacing it upon the pole, a vibration is produced in the needle of the galvanometer. The wires are continued to such a length as to prevent the direct action of the magnet upon the needle of the galvanometer.

Some experiments which by the kindness of Mr. Lukens I was enabled to make with this apparatus resulted in a satisfactory mode of representing the effect which is produced upon the galvanometer in any given position of the coil. I offer it simply as a mode of recollecting the results of observation.

The coil of wire (fig. 2,) was first applied to the north pole of the magnet, the direction of the coil being from right to left above the magnet, the inside wire of the coil was on the left hand, the outside wire on the right, the experimenter facing the north; the outside wire was carried to the south cup of the galvanic multiplier, the inside to the north cup. The poles of the magnet were turned to the south. On withdrawing the coil from the pole, the north pole of the needle was deflected to the west, returning the coil carried the same pole to the east. Changing the wires of the coil in the cups of the galvanometer reversed the direction of the vibration of its needle.

The effect of withdrawing the coil would have been produced by a galvanic current passing through the coil from left to right below the magnet, from right to left above it.

The coil was next changed from right to left, that is, the direction of the coil changed so that it passed from right to left below the magnet, and from left to right above it, the wires which dipped into the cups of the multiplier remained in their places; the inner wire was now to the right hand, the outer wire to the left. On removing the coil from the north pole of the magnet, the north pole of the needle of the multiplier passed to the east, on returning the coil the same pole moved to the west.

This effect would (as before,) have been produced by a galvanic current passing from left to right below the magnet, from right to left above it. The other positions of the coil being examined showed that they might be represented by the same supposition of a circular current about the pole of the magnet, and passing through the wire. The reverse of such a hypothesis is of common application to represent the action of the conjunctive wire of a galvanic battery upon a magnetic needle.

The south pole of the magnet presented opposite results, the effects produced by removing the coil were such as would have occurred in replacing it upon the north pole.

As the removal of the coil produces a contrary effect from that obtained when it is placed upon the pole, the representation is complete from the opposite magnetic currents produced in these cases. When the coil is drawn along the magnet towards the north pole, it is easy to conceive that passing successively to more magnetic parts, or exposed to magnetism of different intensities, the current of magnetism with regard to the wire is from south to north; this, by the reversion of the hypothesis in relation to the galvanic current, produces (since the north pole is towards the operator,) an electrical current from west to east, or from left to right, below the magnet. The same is true for the south pole.

We conclude that the effects of a magnet upon a coil of wire may be represented by an electrical current at right angles to the direction in which the wire moves upon the magnet, and directed below the magnet from west to east when the coil is moved from the south pole to the north pole of the magnet, and vice-versa, the poles of the magnet being turned to the south.

The denominations will change of course if it be considered more convenient to turn both poles to the north.

It would seem easy to bring the facts relating to the removal of the keeper upon which wire is coiled, under the same expression. In that case the magnetism is in motion with respect to the coil, leaving the soft iron which forms the keeper.

With fifteen turns of copper wire upon the prismatic keeper of the magnet before used, a vibration through twenty degrees, at the maximum, was produced : beyond this the power of the current could not carry the needle. The wire was wrapped with silk.

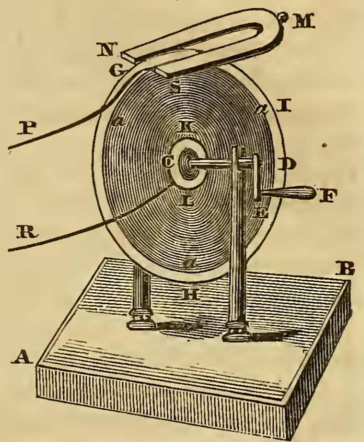
With five turns upon the same keeper a vibration through an arc of ten to twelve degrees was obtained.

The coil being at rest upon the magnet no permanent deflection is produced. This agrees with an observation of Nobili and Antinori.

The amount of vibration may be easily increased by providing two coils, one for each pole, the direction of the coils being opposite to each other, the outer wires of each coil being united as well as the inner ones, the effect of two coils would be produced. They may be separated by a piece of wood, to which being attached, and the wood provided with a handle, the coils may be removed or replaced very coveniently.

Fig. 3. represents Faraday's wheel; G, H, I, being a piece of copper twelve inches in diameter, the circular ring between G, H, I, and *a*, *a*, *a*, is amalgamated, also the ring K, L, near the centre of the plate on the same side with the first ring; the wheel is mounted upon an axis C, D, and turned by a winch. KL, and G, are plates of copper, to apply the one at the amalgamated ring around the axis, the other at the ring at the circumference and between the poles, N and S, of a horse-shoe magnet. G, P, and C, R, are the wires soldered to these plates, their extremities connected with the galvanometer as described above, their length adjusted upon the same principles.

Fig. 3.



In experimenting with Faraday's wheel, the disk K, L, at the centre was pressed constantly against the wheel by fastening a cork between the disk and the support. The piece of copper G was touched to the wheel at intervals so as to assist the vibrations or to destroy them at pleasure. When the wheel was first amalgamated, a deflection in the needle was produced without the aid of the magnet; afterwards no such deflection was observed. Opposite rotations of the wheel produce opposite effects in deflecting the needle of the galvanometer, other parts remaining the same.

Report of the Regents of the University of the State of New York, to the Legislature, March 1, 1832.

The State of N. York, with more than 2,000,000 of people, is happily, very attentive to the great interests of education. It has four Colleges; Columbia College in the city of N. York, from which there are no returns since 1829; Hamilton College at Clinton, with

93 students, and a fund nearly completed (by donation) of $40,000 as a foundation for professorships; Geneva College with 45 students and a clear fund of about $70,000; Union College at Schenectady with 223 students; the last class gave 76 graduates; and the new university in the city of N. York, with a fund of $100,000.

The college of physicians and surgeons in the former place, had 182 students, during the last year, and the college of physicians and surgeons of the Western District at Fairfield, had at the last session 201 students. There are now in the State 59 academies under the Regents, with 4188 pupils, and receiving from the literature fund $10,000, shared among 2,399 students; whereas in 1819 there were but 30 academies that reported themselves; they contained 2,218 students and received but $2,500 of the literature fund distributed among 638 students. The mathematical and physical sciences are more fully cultivated in the academies than literature and the moral sciences; this is attributed to the actual condition and wants of the country, but the state government is impartial on this subject, for the public money is distributed equally to pupils in all the branches of learning whether classical, moral or physical. It is a most interesting fact that there are at school 500,000 children, one fourth of the population of the state, including all between 5 and 16 years of age, except only 7,428.

This state has, wisely, made it an indispensable condition of affording its aid to common schools, that those interested shall aid themselves. In Connecticut, where the interest of a million and a quarter of dollars is distributed among the children of a population of about 300,000 persons, no such condition is annexed to the reception of the public money, which is consequently much less beneficial than it ought to be.

The academies of Potsdam in St. Lawrence County, and of Canandaigua prepare instructors for the common schools; the former furnished, last year, 80 teachers, and it is thought that the academies of the state might furnish 1000 teachers annually. The academies have "convenient edifices, in some cases large permanent funds, valuable libraries and philosophical apparatus, worth, in the whole $500,000." The buildings are worth from $1000 to $90,000 for each establishment. The meteorological results obtained at these academies scattered over a territory which touches at once the Atlantic, the great lakes, and the St. Lawrence, are valuable, and must, in time, present the most important results, of which we may hereafter give some specimens.

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The coloring of the Geological Map, to illustrate Prof. Hitchcock's survey of Massachusetts, has caused the delay in the appearance of the present No. All the copies of the Map that were needed for the Journal, were prepared in season; but several hundreds of them having been required for an immediate supply of the Legislature of Massachusetts, the Journal has been detained until they could be replaced.