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ERRATA.

Page 118, l. 17 from top, for "Jacob," read "Jacobi."—P. 145, l. 12 fr. top, for "Persia," read "Prussia."—P. 186, l. 18 fr. top, for "29° 34′," read "79° 34′."—P. 292, l. 7 from bottom, for "the works of Argenais de Barclai," read, "the Argenais of John Barclay."

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For further particulars, address B. Silliman, Jr.

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Abstract Report of the Proceedings of the Session in May, 1845, *at New Haven.*

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THE

AMERICAN

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[SECOND SERIES.]

ART. I.—*Some Observations on the Ethnography and Archæology of the American Aborigines;* by SAMUEL GEORGE MORTON, M. D., Author of the Crania Americana, Crania Ægyptiaca, &c.

NOTHING in the progress of human knowledge is more remarkable than the recent discoveries in American archæology, whether we regard them as monuments of art or as contributions to science. The names of Stephens and Norman will ever stand preëminent for their extraordinary revelations in Mexico and Yucatan; which, added to those previously made by Del Rio, Humboldt, Waldeck and D'Orbigny in these and other parts of our continent, have thrown a bright, yet almost bewildering light, on the former condition of the western world.

Cities have been explored, replete with columns, bas-reliefs, tombs and temples; the works of a comparatively civilized people, who were surrounded by barbarous yet affiliated tribes. Of the builders we know little besides what we gather from their monuments, which remain to astonish the mind and stimulate research. They teach us the value of archæological facts in tracing the primitive condition and cognate relations of the several great branches of the human family; at the same time that they prove to us, with respect to the American race at least, that we have as yet only entered upon the threshold of investigation.

In fact, ethnography and archæology should go hand in hand; and the principal object I have in view in giving publicity to the following too desultory remarks, is to impress on travellers and others who are favorably situated for making observations, the importance of preserving every relic, organic or artificial, that can throw any light on the past and present condition of our native tribes. Objects of this nature have been too often thrown aside as valueless; or kept as mere curiosities, until they were finally lost or become so defaced or broken as to be useless. To render such relics available to science and art, their history and characteristics should be recorded in the periodicals of the day; by which means we shall eventually possess an accumulated mass of facts that will be all-important to future generalization. I grant that this course has been ably pursued by many intelligent writers, and the American Journal of Science is a fruitful depository of such observations.* With every acknowledgment to these praiseworthy efforts, let us urge their active continuance. Time and the progress of civilization are daily effacing the vestiges of our aboriginal race; and whatever can be done to rescue these vestiges from oblivion, must be done quickly.

We call attention in the first place, to two skulls from a mound about three miles from the mouth of Huron river, Ohio. They were obtained by Mr. Charles W. Atwater, and forwarded to Mr. B. Silliman, Jr., through whose kindness they have been placed in my hands. These remains possess the greater interest, because the many articles found with them present no trace of European art; thus confirming the opinion expressed in Mr. Atwater's letter:—"There are a great many mounds in the township of Huron," he observes, "all which appear to have been built a long time previous to the intercourse between the Indians aud the white men. I have opened a number of these mounds, and have not discovered any articles manufactured by the latter. A piece of copper from a small mound is the only metal I have yet found."

The stone utensils obtained by Mr. Atwater in the present instance, were, as usual, arrow heads, axes, knives for skinning deer, sling-stones, and two spheroidal stones on which I shall offer some

* See more particularly the communications of Mr. R. C. Taylor, in vol. xxxiv, of Mr. S. Taylor, in vol. xxxiv, and of Prof. Forshey in vol. xlix.

remarks in another place. The materials of which these articles are formed, are jasper, quartz, granite stained by copper, and clay slate, all showing that peculiar time-worn polish which such substances acquire by long inhumation.

The two skeletons were of a man and a woman. "They had been buried on the surface of the ground and the earth raised over them. They lay on their backs with their feet to the west." The male cranium presents, in every particular, the characteristics of the American race. The forehead recedes less than usual in these people, but the large size of the jaws, the quadrangular orbits, and the width between the cheek bones, are all remarkably developed; while the rounded head, elevated vertex, vertical occiput and great inter-parietal diameter, (which is no less than 5·7 inches,) render this skull a type of national conformation. (Fig. 1.)

Fig. 1.

The female head possesses the same general character, but is more elongated in the occipital region, and of more delicate proportions throughout.*

Similar in general conformation to these are all the mound and other skulls I have received since the publication of my work on American Crania, viz. five from the country of the Araucos, in Chili, from Dr. Thomas S. Page of Valparaiso; six of ancient Otomies, Tlascalans and Chechemecans, from Don J. Gomez de la Cortina of the city of Mexico; three from near Tampa, in Florida, from Dr. R. S. Holmes, U. S. A.; one from a mound on Blue river, Illinois, from Dr. Brown of St. Louis; and four sent me by Lieut. Meigs, U. S. A., who obtained them from the immediate vicinity of Detroit, in Michigan. To these may be added two others taken from ancient graves near Fort Chartres, in Illinois, by Dr. Wistlizenus of St. Louis; a single cranium from the cemetery of Santiago de Tlatelolco, near the city of Mexico, which I have received through the kindness of the Baron von Gerolt, Prussian minister at Washington; and another very

* We take this occasion to observe, that skulls taken from the mounds, should at once be saturated with a solution of glue or gum, or with any kind of varnish, by which precaution further decomposition is effectually prevented.

old skull from the Indian burying grounds at Guamay, in Northern Peru, for which I am indebted to Dr. Paul Swift. Last but not least, I may add the skull obtained by Mr. Stephens* from a vault at Ticul, a ruined aboriginal city of Yucatan, and some mutilated but interesting fragments brought me from the latter country, by my friend Mr. Norman.†

These crania, together with upwards of four hundred others of nearly sixty tribes and nations, derived from the repositories of the dead in different localities over the whole length and breadth of both Americas, present a conformable and national type of organization, showing the origin of one to be equally the origin of all.

To this prevading cranial type I have already adverted. Even the long-headed Aymaras of Peru, whom, in common with Prof. Tiedemann, I at first thought to present a congenitally different form of head from the nations who surrounded them, are proved, by the recent discoveries of M. Alcide D'Orbigny, to have belonged to the same race as the other Americans, and to owe their singularly elongated crania to a peculiar mode of artificial compression from the earliest infancy.‡

But there is evidence to the same effect, but of more ancient date than any we have yet mentioned. The recent explorations of Dr. Lund in the district of Minas Geraes, in Brazil, have brought to light human bones which he regards as fossil, because they accompany the remains of extinct genera and species of quadrupeds, and have undergone the same mineral changes with the latter. He has found several crania, all of which correspond in form to the present aboriginal type.§

Even the head of the celebrated *Guadaloupe skeleton* forms no exception to the rule. The skeleton itself is well known to be in the British Museum, but wants the cranium, which however is supposed to have been recovered in the one more recently found in Guadaloupe by Mr. L'Hérminier, and brought by him

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* Incidents of Travel in Yucatan, I, p. 281.

† Rambles in Yucatan, p. 217.

‡ L'Homme Americain, Tome I, p. 306. I corrected my error before I had the pleasure of seeing M. D'Orbigny's very interesting work. Amer. Jour. of Science, vol. xxxviii, No. 2. Jour. Acad. Nat. Sciences of Philadelphia, vol. viii; and again in my Distinctive Characteristics of the Aboriginal Race of America, p. 6.

§ See Proceedings of the Acad. of Nat. Sciences of Philadelphia for Dec. 1844.

to Charleston, South Carolina. Dr. Moultrie, who has described this very interesting relic, makes the following observations:—"Compared with the cranium of a Peruvian presented to Prof. Holbrook by Dr. Morton, in the museum of the state of South Carolina, the craniological similarity manifested between them is too striking to permit us to question their national identity. There is in both the same coronal elevation, occipital compression, and lateral protuberance accompanied with frontal depression, which mark the American variety in general."*

There is additional proof of identity, not only of original conformation, but of conventional modification of the form of the head, which I may be excused from reverting to in this place, inasmuch as the materials I shall use have but recently come to my hands. The first of these subjects is represented by the subjoined wood-cut, (fig. 2.) It was politely sent me by Dr. John Houstoun, an intelligent surgeon of the British Navy, with the following memorandum: "From an ancient town called Chiuhiu, or Atacama Baja, on the river Loa, and on the western edge of the desert of Atacama. The bodies are nearly all buried *in the sitting posture*, [the conventional usage of most of the American nations from Patagonia to Canada,] with the hands either placed on each side of the head, or crossed over the breast."†

Fig. 2.

* Amer. Jour. of Science, xxxii, p. 364.

† See Proceedings of the Acad. of Nat. Sciences of Phila., vol. ii, p. 274. If I mistake not, I was the first to bring forward this *mode of interment* practiced by our aboriginal nations, as a strong evidence of the unity of the American race. "Thus it is that notwithstanding the diversity of language, customs and intellectual character, we trace this usage throughout both Americas, affording, as we have already stated, collateral evidence of the affiliation of all the American tribes."—Crania Americana, p. 246, and pl. 69. Mr. Bradford in his valuable work, *American Antiquities*, has added some examples of the same kind; and the Chevalier D'Eichthal has also adduced this custom, in connexion with some traces of it in Polynesia, to prove an exotic origin for a part at least of the American race. See *Mémoires de la Société Ethnologique de Paris*, Tome II, p. 236. Whence arose this conventional position of the body in death? This question has been often asked and variously answered. It is obviously an imitation of the attitude which the living Indian habitually assumes when sitting at perfect ease, and which has been naturally transferred to his lifeless remains as a fit emblem of repose.

This cranium (and another received with it) has that remarkable sugar-loaf form which renders them high and broad in front, with a short antero-posterior diameter, both the forehead and occiput bearing evidence of long continued compression. They correspond precisely with the descriptions given by Cieza, Torquemada and others among the earliest travellers in Peru, who saw the natives in various parts of the country with heads rounded precisely in this manner.*

Fig. 3.

The second head figured, (fig. 3,) is that of a Natchez Indian,† obtained from a mound not far from that city by the late Mr. James Tooley, Jr., and by him presented to me. The face in this, as in the former instance, has all the characteristics of the native Indian; and the cranium has undergone precisely the same process of artificial compression, although these tribes were separated from each other by the vast geographical distance of four thousand miles!

Could we discover the cranial remains of the older Mexican nations, we should doubtless find many of them to possess the same fanciful type of conformation;‡ for if either of the skulls figured above could be again clothed in flesh and blood, would we not have restored to us the very heads that are so abundantly sculptured on the monuments of Central America, and so graphically described by Herrera, when he tells us that the people of Yucatan *flattened their heads and foreheads?*

The following diagrams are copied, on an enlarged scale, from Mr. Stephens's Travels,§ and will serve in further illustration of this interesting subject. They are taken from bas-reliefs in the

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* Crania Americana, p. 116.

† I have been looking to Dr. Dickerson, of Natchez, for more complete details derived from the tumuli of that ancient tribe which formed a link between the Mexican nations on the one hand, and the savage hordes on the other. Dr. Dickerson is amply provided with interesting and important materials for this inquiry, which we trust he will soon make public.

‡ The skull brought me from Ticul by Mr. Stephens, is that of a young female. It presents the natural rounded form; which accords with the observation of M. D'Orbigny, (L'Homme Americain,) that the artificial moulding of the head among some tribes of Peruvians was chiefly confined to the men.

§ Travels in Central America, vol. ii, p. 311.

Palace at Palenque. The personage fig. 4, (whose head-dress we have partly omitted,) appears to be a king or chieftain, at whose feet are two suppliants, naked and cross-legged, of whom we copy the one that preserves the most perfect outline, (fig. 5.)

Fig. 4.

Fig. 5.

The principal figure has better features and expression than the other, but their heads are formed on the same model; whence we may infer that if the suppliant is a servant or a slave of the same race with his master, the artificial moulding of the cranium was common to all classes. If, on the other hand, we assume that he is an enemy imploring mercy, we come to the conclusion that the singular custom of which we are speaking, was in use among other and surrounding nations; which latter inference is confirmed by other evidence, that, for example, derived from the Natchez tribe, and the clay effigies so abundantly found at the ruined temples of the sun and moon at Teotihuacan, near the city of Mexico.*

I can aver that sixteen years of almost daily comparisons have only confirmed me in the conclusions announced in my *Crania Americana*, that all the American nations, excepting the Eskimaux, are of one race, and that this race is peculiar and distinct from all others. The first of these propositions may be regarded as an axiom in ethnography; the second still gives rise to a diversity of opinions, of which the most prevalent is that which would merge the American race in the Mongolian.

It has been objected to a common origin for all the American nations, and even for those of Mexico, that their *monuments*

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* Crania Americana, p. 146.

should present so great a variety in the configuration of the head and face; a fact which forcibly impresses every one who examines the numerous effigies in baked clay in the collection of the American Philosophical Society; yet they are all made of the same material and by the same national artists. The varieties are indeed endless; and Mr. Norman in his first work, has arrived at a reasonable conclusion, in which we entirely agree with him, "that the people prepared these *penates* according to their respective tastes, and with little reference to any standard or canon."*

They appear to have exercised much ingenuity in this way, blending almost every conceivable type of the human countenance, and associating this again with those of beasts, birds, and various fanciful animals, which last are equal in uncouthness to any productions of the Gothic artists of the middle ages.

Mr. Norman in his late and interesting volume of travels in Cuba and Mexico, discovered in the latter country some remarkable ruins near the town of Panuco, and among them a curious sepulchral effigy. "It was a handsome block or slab of stone, (wider at one end than the other,) measuring seven feet in length, with an average of nearly two and a half feet in width and one foot in thickness. Upon its face was beautifully wrought, in bold relief, the full length figure of a man, in a loose robe with a girdle about his loins, his arms crossed on his breast, his head encased in a close cap or casque, resembling the Roman helmet (as represented in the etchings of Pinelli) without the crest, and his feet and ankles bound with the ties of sandals. The figure is that of a tall muscular man of the finest proportions. The face, in all its features, is of the noblest class of the European or Caucasian race."†

Mr. Norman was himself struck "with the resemblance between this, and the stones that cover the tombs of the Knights Templar in some of the ancient churches of the old world," but he thinks that neither this nor any other circumstance proves this effigy to have been of European origin or of modern date. "The material," he adds, "is the same as that of all the buildings and works of art in this vicinity, and the style and workmanship are those of the great unknown artists of the western hemisphere;"

* Rambles in Yucatan, p. 216.

† Rambles by Land and Water, p. 145.

and he arrives at the conclusion, as many ingenuous minds have done before him, that these and the other archæological remains of Mexico and Yucatan, "are the works of a people who have long since passed away; and not of the races, *or the progenitors of the races*, who inhabited the country at the epoch of the discovery."*

With the highest respect for this intelligent traveller, I am not able to agree with him in his conclusion; but I should not now revive my published opinions or contest his, were it not that some new light appears to me to have dawned on this very question.

In the first place, then, we regard the effigy found near Panuco as probably Caucasian; so does Mr. Norman; but instead of referring it to a very remote antiquity, or to some European occupancy of Mexico long before the Spanish conquest, we will venture to suggest, that even if the town of Panuco was itself older than that event, (of which indeed we have no doubt,) it is consistent with collateral facts to infer, that the Spaniards may have occupied this very town, in common with, or subsequent to, the native inhabitants, and have left this sepulchral monument. That the Spaniards did sometimes practice this joint occupancy, is well known; and that they have, in some instances, left their monuments in places wherein even tradition had almost lost sight of their former sojourn, is susceptible of proof.

Mr. Gregg, in a recent and instructive work on the "Commerce of the Prairies," states the following particulars, which are the more valuable since he had no opinions of his own in reference to the American aborigines, and merely gives the facts as he found them.

Mr. Gregg describes the ruins called *La Gran Quivira*, about 100 miles south of Santa Fé, as larger than the present capital of New Mexico. The architecture of this deserted city is of hewn stone, and there are the remains of aqueducts eight or ten miles in length leading from the neighboring mountains. These ruins "have been supposed to be the remains of a *pueblo* or aboriginal city;" but he adds that the occurrence of the Spanish coat of arms in more than one instance sculptured and painted upon the houses, prevents the adoption of such an opinion; and that traditional report (and tradition only) mentions this as a city that

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* Rambles by Land and Water, p. 203.

was sacked and desolated in the Indian insurrection of 1680.* Now had it not been for the occurrence of the heraldic paintings, this city might have been still regarded as of purely Indian origin and occupancy; as might also the analogous ruins of Abo, Tagique and Chilili in the same vicinity; for although these may have been originally constructed by the natives, yet as they are supposed to be near the ancient mines, it is not improbable that the conquerors in these, as in many other instances, drove out the rightful owners, and took possession for themselves;† for that they did possess and inhabit the towns above enumerated is a fact beyond question.

Why may not events of an analogous character have taken place at Panuco? Was it not probably an Indian city into which the Spaniards had intruded themselves, and having left traces of their sojourn, as at *La Gran Quivira*, subsequently, owing to some dire catastrophe, or some new impulse, abandonded it for another and preferable location? This, we suggest, is a reasonable explanation of the presence of the Caucasian effigy found by Mr. Norman among the deserted ruins of Panuco.

Mr. Stephens has, I think, conclusively proved that the past and present Indian races of Mexico were cognate tribes. I had previously arrived at the same conclusion from a different kind of evidence. What was manifest in the physical man is corroborated by his archæological remains. The reiterated testimony of some of the early Spanish travellers, and especially of Bernal Diaz and Herrera, is of the utmost importance to this question; and all that is necessary in the chain of evidence, is some link to connect the demi-civilized nations with the present uncultivated and barbarous tribes. These links have been supplied by Mr. Gregg. Those peculiar dwellings and other structures, with inclined or parapet walls,‡ and with or without windows, which are common to all epochs of Peruvian and Mexican architecture, are constructed and occupied by the Indians of Mexico even at the present day. After describing the general character of these

* Commerce of the Prairies, I, p. 165.

† Ibid. I, 270.

‡ I am aware that the walls of the ancient Mexican and Peruvian edifices are often vertical; but where this is the case the pyramidal form is attained by piling, one on the other, successive tiers of masonry, each receding from the other and leaving a parapet or platform at its base.

modern domicils, Mr. Gregg goes on to observe, that "a very curious feature in these buildings, is that there is most generally no direct communication between the street and the lower rooms, into which they descended from a trap-door from the upper story, the latter being accessible by means of a ladder. Even the entrance at the upper stories is frequently at the roof. This style of building appears to have been adopted for security against their marauding neighbors of the wilder tribes, with whom they were often at war.

"Though this was their most usual style of architecture, there still exists a Pueblo of Taos, composed, for the most part, of but two edifices of very singular structure—one on each side of a creek, and formerly communicating by a bridge. The base story is a mass of near four hundred feet long, a hundred and fifty wide, and divided into numerous apartments, upon which other tiers of rooms are built, one above another, drawn in by regular grades, forming *a pyramidal pile* of fifty or sixty feet high, and comprising some six or eight stories. The outer rooms only seem to be used for dwellings, and are lighted by little windows at the sides, but are entered through trap-doors in the *azoteas* or roofs. Most of the inner apartments are employed as granaries and store-rooms, but a spacious hall in the centre of the mass, known as the *estufa*, is reserved for their secret councils. These two buildings afford habitation, as is said, for over six hundred souls. There is likewise an edifice in the Pueblo of Picuris of the same class, and some of those of Moqui are also said to be similar."*

The Indian city of Santo Domingo, which has an exclusive aboriginal population, is built in the same manner, the material being, as usual, sun-burnt bricks; and my friend Dr. Wm. Gambel informs me, that in a late journey from Santa Fé across the continent to California, he constantly observed an analogous style of building, as well in the dwellings of the present native inhabitants, as in those older and abandoned structures of whose date little or nothing is known.

Who does not see in the builders of these humbler dwellings, the descendants of the architects of Palenque, and Yucatan? The style is the same in both. The same objects have been arrived at by similar modes of construction. The older structures

* Commerce of the Prairies, I, p. 277.

are formed of a better material, generally of hewn stone, and often elaborately ornamented with sculpture. But the absence of all decoration in the modern buildings, is no proof that they have not been erected by people of the same race with those who have left such profusely ornamented monuments in other parts of Mexico; for the ruins of Pueblo Bonito, in the direction of Navajo, and those of the celebrated Casas Grandes on the western Colorado, which were regarded by Clavigero as among the oldest Toltecan remains in Mexico, are destitute of sculpture or other decoration. In fact, these last named ruins appear to date with the primitive wanderings of the cultivated tribes, before they established their seats in Yucatan and Guatimala, and erected those more finished monuments which could only result from the combined efforts of populous communities, acting under the favorable influence of peace and prosperity. Every race has had its center or centers of comparative civilization. The American aborigines had theirs in Peru, Bogota and Mexico. The people, the institutions and the architecture were essentially the same in each, though modified by local wants and conventional usages. Humboldt was forcibly impressed by this archæological identity, for he himself had traced it, with occasional interruptions, over an extent of a thousand leagues; and we now find that it gradually merges itself into the ruder dwellings of the more barbarous tribes; showing, as I have often remarked, that there is, in every respect, a gradual ethnographic transition from these into the temple-builders of every American epoch.*

I shall close this communication by a notice of certain *discoidal stones* occasionally found in the mounds of the United States. Of these relics I possess sixteen, of which all but two were found by my friend Dr. Wm. Blanding, during his long residence in Camden, South Carolina. These disks were accompanied, as usual, by earthern vessels, pipes of baked clay, arrow-heads and other articles, respecting which Dr. Blanding has given me the following locality:—"All the Indian relics, save three or four, which I have sent you, were collected on or near the banks of the Wateree river, Kershaw district, South Carolina; the greater part from the mounds or near the foot of them. All the mounds

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* See my Inquiry into the Distinctive Characteristics of the Aboriginal Race of America, 2d edit., Philad. 1844.

that I have observed in this state, excepting these, do not amount to as many as are found on the Wateree within the distance of twenty four miles up and down the river, between Lancaster and Sumpter districts. The lowest down is called Nixon's mound, the highest up, Harrison's."

"The discoidal stones," adds Dr. Blanding, "were found at the foot of the different mounds, not in them. They seemed to be left, where they were no doubt used, on the play grounds."

The disks are from an inch and a half to six inches in diameter, and present some varieties in other respects.

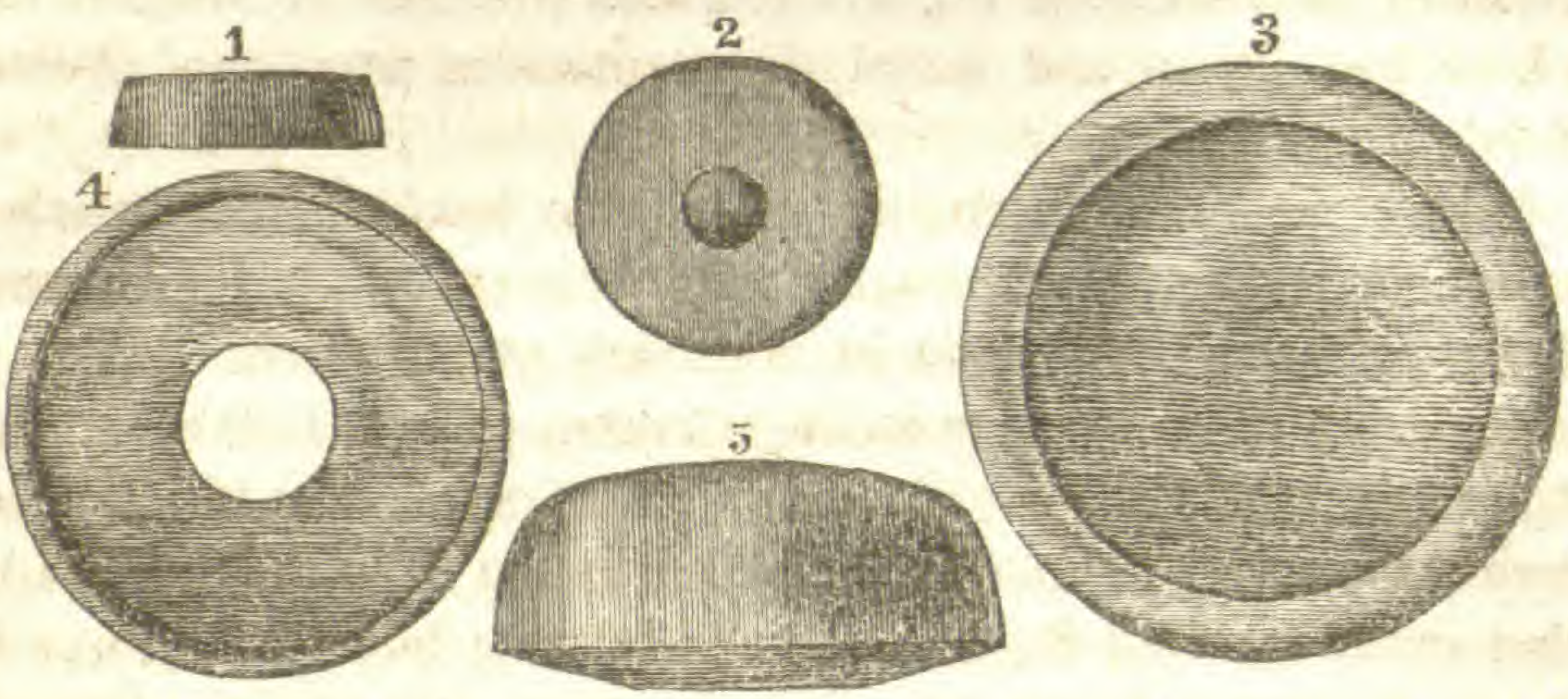

Fig. 1 represents a profile of the simplest form and at the same time the smallest size of these stones, being in diameter about an inch and three quarters. The upper and under surfaces are nearly plane, with angular edges and oblique margin, but without concavity or perforation.

Fig. 2. A similar form, slightly concave on each surface.

Fig. 3. A large disk of white quartz, measuring five inches in diameter and an inch and three fourths in thickness. The margin is rounded, and both surfaces are deeply concave though imperforate.

Fig. 4 is another specimen four inches in diameter, deeply concave from the margin to the center, with a central perforation. The margin itself is slightly convex. The concave surface is marked by two sets of superficial grooved lines, which meet something in the form of a bird-track. This disk is made of a light-brown ferruginous quartz.

Fig. 5 is a profile view of a solid lenticular stone, much more convex on the one side than the other, formed of hard syenitic rock.

Besides these there are other slight modifications of form which it is unnecessary to particularize.

These disks are made of the hardest stones, and wrought with admirable symmetry and polish, surpassing any thing we could readily conceive of in the humbler arts of the present Indian tribes; and the question arises, whether they are not the works of their seemingly extinct progenitors?—of that people of the same race, (but more directly allied to the Toltecans of Mexico,) who appear in former times to have constituted populous and cultivated communities throughout the valley of the Mississippi, and in the southern and western regions towards the gulf of Mexico, and whose last direct and lineal representatives were the ill-fated Natchez?

I have made much inquiry as to the localities of these and analogous remains, but hitherto with little success. I am assured that they have been found in Missouri, perhaps near St. Louis; and in very rare instances in the northern part of Delaware. Dr. Ruggles has sent me the plaster model of a small, perforated, but irregularly formed stone of this kind, taken from an ancient Indian grave at Fall River in Rhode Island; but Dr. Edwin H. Davis, of Chilicothe, in a letter recently received from him, informs me that he had obtained, during his excavations in that vicinity, no less than "two hundred flint disks in a single mound, measuring from three and a half to five inches in diameter, and from half an inch to an inch in thickness, of three different forms, round, oval and triangular." These appear, however, to be of a different construction and designed for some other use than those I have described; and Dr. Davis himself offers the probable suggestion, that "they were rude darts blocked out at the quarries for easy transportation to the Indian towns." The same gentleman speaks of having found other disks formed of a micaceous slate, of a dark color and highly polished. These last appear to correspond more nearly to those we have indicated in the above diagrams.

Besides these disks, I have met with a few spheroidal stones, about three inches in diameter. One of these accompanies the disks from South Carolina, and is marked with a groove to receive the thumb in throwing it. A similar but ruder ball is contained among the articles found by Mr. Atwater in the mound near Huron, Ohio.

What was the use of the disks in question? Those who have examined the series in my possession have offered various explanations; but the only one that seems in any degree plausible, is that of my friend Dr. Blanding, who supposes them to have been used in a game analogous to that of the quoits of the Europeans. It is a curious fact that discoidal stones much resembling these have been found in Scandinavia;* whence I was at first led to suppose it possible, especially in consideration of their apparently circumscribed occurrence in this country, that they might have been introduced here by the Northmen; a conjecture that seems to lose all foundation since these relics have been found as far west as the Mississippi.

Note.—Since the preceding remarks were written, I have received from my friend, Mr. William A. Foster, of Lima, ten skulls and two entire mummied bodies from the Peruvian cemetery at Arica. "This cemetery," observes Mr. Foster, "lies on the face of a sandhill sloping towards the sea. The external surface occupied by these tombs, as far as we explored, I should say was five or six acres. In many of the tombs three or four bodies were found clustered together, always *in the sitting posture*, and wrapped in three or four thicknesses of cloth, with a mat thrown over all."

These crania possess an unusual interest, inasmuch as, with two exceptions, they present the horizontally elongated form, in every degree from its incipient stage to its perfect development.

By what contrivance has the rounded head of the Indian been moulded into this fantastic shape? I have elsewhere† offered some explanations of this subject; but the present series of skulls throws yet more light on it, and enables me to indicate the precise manner in which this singular object has been attained.

It is evident that the forehead was pressed downwards and backwards by two compresses, (probably a folded cloth,) one on each side of the frontal suture, which was left free; a fact that explains the cause of the ridge, which, in every instance,

* See Journal of the Antiquarian Society of Denmark, published in Copenhagen in the Danish language, vol. i, tab. 2, figs. 52, 53.

† Jour. Acad. Nat. Sciences of Philad., vol. viii.

replaces that suture by extending from the root of the nose to the coronal suture. To keep these compresses in place, a bandage was carried over them from the base of the occiput obliquely forwards; and then, in order to confine the lateral portions of the skull, the same bandage was continued by another turn over the top of the head, immediately behind the coronal suture, and probably with an intervening compress; and the bandaging was repeated over these parts until they were immovably confined in the desired position.

Every one who is acquainted with the pliable condition of the cranial bones at birth, will readily conceive how effectually this apparatus would mould the head in the elongated or cylindrical form; for, while it prevents the forehead from rising, and the sides of the head from expanding, it allows the occipital region an entire freedom of growth; and thus without sensibly diminishing the volume of the brain, merely forces it into a new though unnatural direction, while it preserves, at the same time, a remarkable symmetry of the whole structure. The following outline of one of these skulls, will further illustrate my meaning; merely premising that the course of the bandages is in every instance distinctly marked by a corresponding cavity of the bony structure, excepting on the forehead, where the action of a firm compress has left a plane surface.

This conformation, as we have already observed, was prevalent among the old Aymara tribes which inhabited the shores and islands of the Lake of Titicaca, and whose civilization seems evidently to antedate that of the Inca Peruvians. I was in fact at one time led to consider this form of head as peculiar to, and characteristic of, the former people; but Mr. Foster's extensive observations conclusively prove that it was as common among some tribes of the sea coast, as among those of the mountainous region of Bolivia; that it belonged to no particular nation or tribe; and that it was, in every instance, the result of mechanical compression.

In my Crania Americana I have given abundant instances of a remarkable vertical flattening of the occiput, and irregularity of its sides, among the Inca Peruvians who were buried in the royal cemetery of Pachacamac, near Lima. These heads present no other deviation from the natural form; and even this irregularity I have thought might be accounted for by a careless mode of binding the infant to the simple board, which, among many Indian tribes of both North and South America, is a customary substitute for a cradle. It is probable, however, that even this configuration was intentional, and may have formed a distinctive badge of some particular *caste* of these singular people, among whom a perfectly natural cranium was of extremely rare occurrence.

We are now acquainted with *four* forms of the head among the old Peruvians which were produced by artificial means, viz:

1. The horizontally elongated, or cylindrical form, above described.

2. The conical or sugar-loaf form, represented in the preceding diagrams.

3. The simple flattening or depression of the forehead, causing the rest of the head to expand, both posteriorly and laterally; a practice yet prevalent among the Chenooks and other tribes at the north of the Columbia river, in Oregon.

4. A simple vertical elevation of the occiput, giving the head in most instances a squared and inequilateral form.

A curious decree of the ecclesiastical court of Lima, dated A. D. 1585, and quoted by the late Prof. Blumenbach, alludes to at least four artificial conformations of the head, even then common among the Peruvians, and forbids the practice of them under certain specified penalities. These forms were called in the language of the natives, "Caito, Oma, Opalla, &c.;" and the continuance of them at that period, affords another instance of the tenacity with which the Peruvians clung to the usages of their forefathers.

Art. II.—*On a new process for obtaining Formic Acid, and on the preparation of Aldehyde and Acetic Acid by the use of the Bichromate of Potassa;* by Profs. W. B. Rogers and R. E. Rogers of the University of Virginia.

I. *Process for Formic Acid.*

Since the important discovery of Döbereiner, that formic acid is evolved from a mixture of tartaric acid, peroxide of manganese and sulphuric acid, the progress of research has shown that in a large proportion of cases, where organic matters are exposed to powerful oxidating agencies, this acid is among the products developed; and hence several other processes have been devised for its preparation, on the large scale and in the laboratory. Of these the one generally in use consists, as is well known, in distilling a mixture in prescribed proportions, of peroxide of manganese, dilute sulphuric acid and starch or sugar.

The inconsiderable amount of acid yielded by this process, and its usually large admixture with other products, especially sulphurous acid, suggested to us, some time ago, the trial of bichromate of potassa, as a substitute for peroxide of manganese, and has since led us to a method of operating, which we think presents decided advantages over that in general use.

When bichromate of potassa, dilute sulphuric acid and sugar are mingled in proper proportions and in a proper order, a large amount of formic acid is developed, of which part passes off during the first violent reaction, and the remainder is separable by gentle distillation. Repeated experiments have convinced us that by mingling all the materials at once, before placing them in the retort, a comparatively small product is obtained, partly from its being volatalized by the high temperature attending the reaction, and partly, we think, because more of the sugar is carried to its highest stage of oxidation in the forms of carbonic acid and water. We have therefore been led to another, and we believe, better mode of operating, of which the following details will serve as an example.

Introducing into a retort, capable of holding about one quart, 800 grains of bichromate of potassa and 10 cubic inches of water, we gently heat the mixture so as to dissolve the larger part of the bichromate. We then add 300 grains of powdered white sugar, and adjusting to the tubulure a perforated cork and pipette with gum-elastic bag for the gradual introduction of sulphuric acid, we slowly inject about 1 cubic inch of the latter upon the mixture. By regulating the addition of the acid and occasionally intermitting the slender stream, the violent reaction which ensues is prevented from occasioning any very great intumescence. During this stage of the operation, upwards of 2 cubic inches of a clear but feebly acid liquid passes over into the receiver. When the action has in a good measure subsided, we add 5 cubic inches more of water, and apply a gentle lamp heat, continuing the addition of the acid, by allowing it simply to drop from the pipette, until another cubic inch has been introduced. The liquid which now passes over is much stronger in formic acid than in the preceding stage, and the distillation may, without impairing the purity of the product, be continued until about 7 cubic inches have been received. By urging it much beyond this point sulphurous acid will be evolved.

One hundred grains of the liquid thus obtained is capable of saturating about seven grains of dry carbonate of soda. Its purity is such as to fit it for immediate use in illustrating the striking reactions of formic acid and the formiates. Thus—

1. On adding a small portion of it to a solution of nitrate of silver previously curdled by ammonia, and applying heat, the silver is promptly reduced with a lively effervescence of carbonic acid.

2. With a solution of bichloride of mercury, aided by heat, it causes a precipitation of calomel and the evolution of hydrochloric and carbonic acids.

3. Combined with soda it forms a white salt readily carbonized by heat and passing into carbonate.

4. It is not blackened by sulphuric acid, but the soda salt acted upon by this acid evolves carbonic oxide with brisk effervescence.

5. This salt heated with solution of nitrate of silver or nitrate of mercury, precipitates the metal with evolution of carbonic acid.

All these results are so prompt and striking as to evince but little contamination of the formic acid with other products.

On comparing this process with that commonly employed, we are convinced of its superiority, first, on account of the exemption of the product from SO_2, and in a great degree from other impurities; second, from the much larger amount of formic acid obtained by it from an equal weight of the oxidizing material, sulphuric acid and starch or sugar; and third, from the ease with which the action is controlled.

According to Liebig, (Chem. Org., p. 567,) 10 parts of starch, 37 parts of peroxide of manganese, and 30 parts of sulphuric acid, yield 3·35 parts of an acid liquid, of which 100 grains saturate 15 grains of carbonate of soda. This corresponds to 7·18 parts of liquid such as we obtain. We have thus by the old process 7·18 parts of liquid of equal acidity with our product, while the aggregate weight of the starch, sulphuric acid, and peroxide of manganese is 77. By our process we have about 1800 grains of a similar acid from 2100 grains of sugar, bichromate of potassa and sulphuric acid. In other words, *by the new process, we procure about nine times as much formic acid from the same weight of the three reacting materials, as by that hitherto in use.*

II. *On the preparation of Aldehyde and Acetic Acid by the use of the Bichromate of Potassa.*

In the process described by Liebig, (Chem. Org., p. 378,) and which is the one hitherto generally used for preparing aldehyde in the regular way, the product is obtained from the reaction of peroxide of manganese and sulphuric acid upon dilute alcohol. This operation furnishes a liquid which is so weak in aldehyde, and so mixed with water and formic ethers, and as we have found with acetic acid also, as to present the characteristic reactions only in a feeble degree, and to require two rectifications over chloride of calcium, before it can be used in forming the subacetylite or aldehydite of ammonia.

In the course of some experiments upon the reactions of bichromate of potassa and sulphuric acid upon alcohol, we have been led to a process which affords a larger and much purer product, and which is entirely under the control of the operator. The distinctive features of this method are the substitution of bichromate of potassa for the peroxide of manganese, and the peculiar mode of bringing the reacting materials together. In the use of the bichromate we have since found that we were anticipated by Prof. Kane, who, at page 922 of his Elements of Chemistry, recommends it as a means of obtaining a purer product, and specifies briefly the manner in which he conducted the process. As however his method is not noticed in other chemical works, and as our mode of proceeding and some of the results we have obtained, are, we think, not without novelty and interest, we deem them worthy of a brief notice in your Journal.

When alcohol is added to a strong aqueous solution of chromic acid in a retort, a very brisk reaction ensues, and upon applying a gentle heat there passes over a clear liquid, containing a considerable amount of aldehyde, with a faint trace of acetic and probably formic acids. The presence of the aldehyde is readily shown by adding a few drops of the liquid to a solution of nitrate of silver previously curdled by ammonia, and then gently heating the mixture. The oxide is speedily reduced, forming a brilliant metallic coating on the sides of the glass.

Substituting for the chromic acid of this experiment, a mixture of bichromate of potassa and sulphuric acid, and blending with this a quantity of common alcohol, the reaction is extremely violent, a large volume of carbonic acid is evolved, and the liquid which distils over, contains, with other products, *much aldehyde and acetic acid.* To obtain either of these substances but little mingled with the rest, special attention must be paid to the proportions in which the bichromate, sulphuric acid, and alcohol are mixed, and to the order in which they are brought together. Thus, in all our experiments, we found, than when *alcohol* is added *in small quantities at a time* to a mixture of the bichromate and sulphuric acid the distilled product is almost *pure acetic acid*, but when *sulphuric acid* is *slowly dropped* into a mixture of the salt and alcohol, the liquid which passes over contains little else than *aldehyde.*

This remarkable difference in the products is, we think, readily explained by the different intensity of the oxidating power in the two cases. In the former, the alcohol, as it falls into the mixture of bichromate and sulphuric acid, being surrounded on all sides by free chromic acid, is carried rapidly through the lower stages of oxidation, corresponding to aldehyde and aldehydic acid, until by the addition in all of 4 equivalents of oxygen, and the elemination of 2 equivalents of water, it is converted into acetic acid. In the latter case, the sulphuric acid, dropping slowly into the mixture of alcohol and bichromate, liberates but a small quantity of chromic acid at any one time, and thus limits the oxidation of the alcohol in great part to the first stage, or that of the formation of aldehyde.

From the observation of these facts, we were led, after a number of comparative trials, to the following process for the preparation of aldehyde.

Equal weights of powdered bichromate of potassa and alcohol, sp. gr. 0·842 being placed in a capacious retort, connected with a receiver and the usual means of refrigeration, we adapt to the tubulure a pipette, charged with sulphuric acid, and whose stem reaches nearly to the surface of the liquid, the top of the pipette being furnished with a strong gum-elastic bag for injecting the acid into the mixture beneath. We now slowly add the acid, taking care to avoid excessive reaction, by sometimes allowing it merely to drop spontaneously from the pipette, and again when the action subsides accelerating its flow by pressure. At this period of the operation, the heat evolved in the retort is sufficient to carry over into the receiver a considerable volume of the aldehydic liquid; and, as much carbonic acid is at the same time disengaged, the tubulure of the receiver should only be loosely closed. Having thus added gradually a weight of sulphuric acid equal to about 1½ times that of the bichromate, we apply a gentle lamp heat and continue the distillation as long as the aldehydic liquid passes over. When the reaction is most energetic, white fumes are evolved, which, falling from the beak of the retort into the receiver, are so dense that they may readily be poured from the latter through a funnel into a narrow necked bottle. These, when condensed, form a clear liquid consisting chiefly of aldehyde.

By this process 1500 grains of bichromate of potassa and the same amount of alcohol have on repeated occasions yielded us about 8 cubic inches of a clear liquid, containing but slight traces of acetic acid or other extraneous matters, and possessing all the characters of a nearly pure mixture of aldehyde and water.

The product thus obtained is sufficiently rich in aldehyde to exhibit instantly and strikingly all the characteristic reactions of that substance. It may, therefore, without rectification, be employed in class-room experiments and in testing for silver.

A few drops of this liquid, added in a test tube to a solution of nitrate of silver previously curdled by ammonia, quickly converts the oxide into metallic silver, which attaches itself as a brilliant coating to the glass. In describing this characteristic property of aldehyde, Liebig and others appear to regard the *application of heat* to the mixture as necessary to the effect, (Chem. Org., p. 377.) We have found however that the aldehydic liquid of the above process, as well as the more concentrated aldehyde procured from it by distillation over chloride of calcium, causes a complete and brilliant reduction of the oxide of silver in a few seconds *at ordinary temperature*, and that the same effect results even *when the tube is immersed in snow*, but in this case the change requires two or three minutes for its completion.

Heated with hydrate of potassa the liquid becomes yellow, then of a deep reddish brown color, and in a little while yields floating flakes of the characteristic *resin of aldehyde.*

On adding to the liquid an excess of caustic baryta in the cold, little or no action is manifested; but as soon as heat is applied, the mixture assumes an intense opaque yellow color like that of chromate of lead, which by continuing the heat passes into a deep rich brown, as in the preceding experiment.

The proportion of aldehyde in the liquid as it comes from the receiver in the above process, is such, that to prepare *aldehydite of ammonia*, we may dispense with the two successive distillations from the chloride of lime directed by Leibig, and use the fresh product at once for this purpose. We therefore add to the liquid about half its bulk of sulphuric ether, and pass a stream of ammonia into the mixture. As the aldehyde becomes saturated, the compound in question falls in an abundant deposit of brilliant transparent rhombohedral crystals. From this, as is well known, perfectly pure aldehyde is prepared by the reaction of dilute sulphuric acid.

In some experiments made to determine the delicacy of aldehyde as a test for oxide of silver, we obtained the following results:—

1. A solution of 1 part of nitrate of silver in 1000 of distilled water, when heated gently in a test tube with a drop or two of aldehydite of ammonia, formed a brilliant metallic pellicle on the inner surface of the glass.

2. A solution containing 1 part in 2000 produced the pellicle in distinct spots and not continuous as in the former case. At the same time the liquid became of a deep greenish purple color, and although only one quarter of an inch thick was nearly opaque.

3. A solution of 1 part in 10,000 gave no adherent pellicle, but on continuing the heat for two or three minutes became strongly colored, presenting a deep greenish purple by transmitted, and a dull olive by reflected light.

4. In a solution of 1 part in 20,000, the peculiar greenish purple tint was still quite decided, and even when the solution was diluted so as to contain only $\frac{1}{40000}$th of nitrate of silver this color was very distinctly manifested after heating it sometime with aldehydite. Compared with the faint opalescence caused by the addition of chloride of sodium to the same solution, this effect of the aldehyde appeared to be the more striking of the two.

The peculiar purplish tint of the liquid, remarked in these experiments, is evidently due to the finely divided metallic silver held in suspension, and affords therefore a striking confirmation of the statement of Dupasquier, that not only gold, but silver and other opaque bodies, present this hue when greatly subdivided and viewed through a clear suspending medium, (Comp. Rend., No. 1, July, 1845.) It may be added that the same hue is developed when a very dilute solution of nitrate of silver is subjected to the reducing action of a formiate.

Allusion has already been made to the production of *acetic acid* in large amount by a modification in the above process. For this purpose the powdered bichromate and the sulphuric acid in the proportion of about 2 to 3, are to be first mixed in the retort so as to develop a large amount of free chromic acid. The alcohol is then introduced from the pipette as in the former case and with like precautions. During the violent action that ensues, much acetic acid passes over without the aid of external heat. When the alcohol thus added amounts to about twice the weight of the bichromate employed, the action having subsided, we apply a gentle lamp heat and obtain a large additional quantity of the acid. This we have found to be free from sulphurous acid and to contain little more than a trace of formic acid and aldehyde.

ART. III.—*On the Evidence of Fossil Footprints of a Quadruped allied to the Cheirotherium, in the Coal Strata of Pennsylvania;* by CHARLES LYELL, Esq., F. R. S., F. G. S., &c.

(Communicated by the Author.)

ON my way from Pittsburg to Philadelphia, I visited the rocks in which Dr. King, of Greensburg, first discovered, in 1844, the footmarks supposed to have been made by a large reptile, and which stand out in relief from the lower surface of slabs of sandstone, resting on a thin layer of fine clay. Having visited the quarry and enquired into all the circumstances of the discovery, having seen almost every specimen hitherto obtained, and considered the relations of the sandstone with the rocks lying above and below it, I have no hesitation in declaring my conviction, first, that the footprints are genuine, and were made by a quadruped nearly allied to the Cheirotherium of Europe, if not the same; secondly, that they occur in the middle of the carboniferous formation, having both above and below them seams of coal and strata containing Lepidodendron, Sigillaria, Stigmaria, Calamites, &c.

Great praise is due to Dr. King for the exertions which he has made in bringing these fossils to light, and duly appreciating from the first their extraordinary importance and value. A young man, engaged in an extensive medical practice in a remote town, acting under every discouragement which want of sympathy in those immediately around him, and of access to scientific books or museums could produce, he has persevered and succeeded in forming a fine collection of the fossil tracks, and become acquainted with the relations and organic remains of the contiguous strata.*

I shall begin by describing the first locality to which the attention of Dr. King was called in 1844, a stone quarry about five miles S. E. of Greensburg in Westmoreland county, Pennsylvania. The slabs of argillaceous sandstone are extracted here for paving, but the excavation begun in the bank of a small stream was soon desisted from in consequence of the increasing thickness of the

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* Three papers have appeared in this Journal from Dr. King. The first describes and figures the footmarks from five miles S. E. of Greensburg, vol. xlviii, p. 343; the second, those of Derry, vol. xlix, p. 216; and lastly, the supposed hoofed-prints at Connelsville, second series, vol. i, p. 268.

overlying useless shale. Between the slabs of stone, which are a few inches thick, are thin parting layers of a fine unctuous clay well fitted to receive and retain faithful impressions of the feet of animals. About twenty three footsteps have been observed, some more and others less distinct. One of these was seen by Dr. King, to be impressed on the upper surface of a layer of clay, but the specimen was unfortunately left exposed to the weather and destroyed. The other Cheirotherium footsteps stand out in relief from the under surface of a bed of sandstone, and are accompanied by small mud-veins which have been described as fucoids for which they were mistaken. They are in fact casts of those cracks of various sizes which are produced by the drying and shrinking of mud. As the footprints are traversed and occasionally distorted by these veins, it is evident that the shrinkage took place after the animal had walked over the mud. There is every where seen a double row of tracks, which occur in pairs, each pair consisting of a hind and fore foot, and each being at nearly equal distances from the next pair. The toes, on each of these parallel rows, turn, the one set to the right, the other to the left.

The geological position of this sandstone is perfectly clear. It is situated in the midst of the Apalachian coal field, and there is no formation to be seen, except the carboniferous, for a considerable distance in any direction. The beds are gently inclined to the S. E., and occur on the side of one of those troughs which intervene between two anticlinal folds or ridges which are not only found in the principal chain of the Alleghany mountains, but also, as in this instance, in the lower and less hilly country immediately west of the mountains. The sandstone and shale containing the footsteps, crop out from beneath the main or Pittsburg seam of coal, which is about nine feet thick, and has been worked at its outcrop in the immediate neighborhood. This coal is less than a hundred feet above the sandstone, and there are several other seams of workable coal which lie at lower levels; and impressions of Lepidodendron, Sigillaria, Stigmaria, Calamites, ferns, and other carboniferous plants, have been found both above and below the level of these reptilian footsteps.

The second locality which I visited, where the supposed fossil footprints of birds and of quadrupeds resembling dogs, were observed by Dr. King, is situated within a mile of the town of

Derry in Westmoreland county, about fourteen miles north of Greensburg, (see this Journal, vol. xlix, p. 216.) The markings here are all upon the surface of a white coal grit or sandstone, forming a bare ledge of rock, no vegetation, scarcely even any mosses or lichens having grown on the pure quartzose stone. The ledge is about thirty five feet in its longest diameter, and about thirty two in breadth. It projects above the general level about three feet at one end, and slopes down gradually but irregularly till it is only an inch or two high at the lower extremity. There are several other similar but much smaller ledges of bare sandstone within a very short distance, on which there are no footprints. The large ledge is covered with distinct representations, not only of the tracks of birds and dogs, but also of other animals. Those of birds in particular, are cut sharply and deeply, and there is one long series of steps in succession, as if a bird had walked from the lower to the upper end of the ledge, and then over the end, so as to leave on a steep slope inclined to the horizon at an angle of 22°, a clear and vivid imprint. I found it quite impossible to imagine the layers of sand when in a soft state or capable of receiving footprints, to have been ever so placed, as to admit of such an impression being made, and it is obvious that after the loose sand had consolidated and the ledge had acquired its present form by denudation, no bird could have left the slightest trace of its passage over so hard a rock. I may state indeed that I have never seen in Germany, England, or America, any impressions of the tracks of birds or quadrupeds indented on so coarse a sandstone as that of Derry, although casts in relief have frequently been taken in such a matrix, the sand having been poured into the hollows made in the soft mud on which the animals had trodden.

Another serious objection to the supposed geological antiquity of the footprints, presented itself to me on my first view of this ledge near Derry. The impressions are most of them extremely sharp, although the sandstone has not only been exposed for ages to the weather, but evidently acted upon by currents of water, which have shaped out channels and cavities of various depths, and some perfectly round, deep, and regularly formed pot-holes, one of them eighteen inches deep and more than a foot in diameter. I counted on this single ledge no less than nineteen pot holes, between some of which, part of the principal series of bird tracks passes.

Another objection to the genuineness of the footprints, arises from the unevenness of the surface of the rock, on which, as the successive layers lie nearly horizontal (which is shown by sections exhibited in the vertical walls of the pot-holes,) distinct planes of stratification are laid open. The only way of imagining how so great a multitude of tracks could be exposed superficially on many different planes, would be to suppose that each superimposed layer was originally covered with these markings, all the tracks turning in one direction, so that wherever the excavating power of water cut into a subjacent layer, it laid open to view some new tracks. But this hypothesis is so far from being borne out by the facts, that after cutting into the stone in more than twenty places and removing small slabs with imprints upon them, Dr. King has never been able to detect a single indication of a footprint in the rock below.

I have lately seen good imitations of the tracks of birds on a slab of limestone sculptured by Indians, at New Harmony, in the museum of Dr. D. D. Owen. It was brought from St. Louis in the state of Missouri. The different joints of the toes were indicated as in the Derry stone. In the immediate neighborhood of the ledge of Derry there are numerous graves of Indians, and the same place is known to have lain in the line of one of their paths leading from the Alleghany mountains to the west.*

It seems indeed, in the highest degree probable, that the aborigines of North America, whose skill in following the trail of all kinds of game is so well attested, and who are known to have cut in some places on the rocks, rude imitations of the forms of animals, should sometimes have employed, as the symbols of the birds or quadrupeds which they hunted, a copy of these footprints with which they were so familiar. But the true origin of these markings on the Derry sandstone, may, I think, be considered as set at rest by observations lately made in another locality

* The supposed *human footprints* in solid limestone, first discovered and figured by Mr. Schoolcraft in 1822, and considered by him to be genuine fossils, (Am. Jour. Sci., vol. v, p. 223,) will not soon be forgotten. These curious intaglios remained for twenty years unexplained, until Dr. Owen, in 1822, (Amer. Jour. of Science, vol. xliii, p. 14,) demonstrated to the satisfaction of all, their artificial origin, and attributed them (justly no doubt) to the ancient inhabitants of America. We refer the reader to his most interesting paper for a full detail of the evidence, with figures of the acompanying fossils, and some of the instruments which may have been used in the process of sculpture.—*Eds.*

in Fayette county, near Connelsville, (Second Series, vol. i, p. 268,) nineteen miles from Greensburg, and about thirty from Derry.

Dr. King and the Rev. Mr. Hackey have visited this place, and they inform me that on the surface of a hard ledge of sandstone exposed there, some unquestioned Indian hieroglyphics with the representation of two human heads and of a serpent, are to be seen. These are accompanied with tracks of birds and of hoofed quadrupeds, and lastly of a footprint resembling exactly that of a dog or wolf, and identical with some of the most common tracks on the stone at Derry.

I have now only to express my thanks to Dr. King for the assistance which he gave me in prosecuting these inquiries, in which his sole desire was to arrive at the truth, and to correct any mistakes into which he might have fallen. He now agrees with me in regarding those imprints only as genuine and fossil, which occur in Unity township, five miles from Greensburg. They consist, as I before stated, of the tracks of a large reptilian quadruped, in a sandstone in the middle of the carboniferous series, a fact so full of novelty and interest, that when we reflect on its importance, all disappointment in the abandonment of the spurious footprints is forgotten. In no formation have so many excavations affording facilities of palæontological researches in Europe and America been made, as in the carboniferous. No other group of strata has yielded such unequivocal evidence of the presence on the spot, of dry land, or of its existence in the immediate vicinity; and yet here in Pennsylvania, for the first time we meet with evidence of the existence of air-breathing quadrupeds capable of roaming in those forests, where the Sigillaria, Lepidodendron, Caulopteris, Calamites, Ferns, and other plants, flourished. Few geologists will now think it safe to assume, that no other species or genus or even class of terrestrial vertebrata existed at that period.

In conclusion, it may be proper for me to state, that having formerly examined, in company with Prof. Hitchcock, the Ornithichnites of the valley of the Connecticut river, I have by no means been led to doubt the genuineness of those imprints from what I saw at Derry. The fossil markings on the Connecticut are not superficial, but found under circumstances in all respects most strictly analogous to those which have led me to believe in the reality of the Cheirotherium of the coal strata near Greensburg.

Philadelphia, April 26, 1846.

Art. IV.—*Description and Analysis of a new Mineral Species, containing Titanium; with some remarks on the Constitution of Titaniferous Minerals;* by Thomas S. Hunt of the Laboratory of Yale College.

This mineral, which is here described, accurs at Amity, New York, imbedded in a white magnesian limestone, with serpentine, ilmenite, spinelle and chondrodite. In its physical characteristics, it resembles closely Warwickite from the same neighborhood, and indeed the specimen which I have analyzed, was handed to me as a specimen of Warwickite; but its chemical characters and composition differing so much from those obtained for that mineral, I offer it as a new species, and would propose for it, the name of *Enceladite*, after *Enceladus* one of the Titans of ancient mythology.

Mineralogical Description.—Primary form. An oblique rhombic prism. M on M = about 93°: but from the roughness of its faces it is impossible to measure the angles accurately.

Secondary form. The primary with its obtuse lateral edges replaced; the summits of the smaller crystals terminated by imperfect planes and rounded. Cleavage with the longer diagonal, very perfect; brittle; fracture uneven.

Lustre, in the larger crystals glimmering, in the smaller ones resinous, sometimes submetallic on the cleavage surfaces.

Color, iron or bluish black passing into brownish black; streak bluish black.

Hardness 3—4. Specific gravity 3·188.

Chemical Examination.—When heated in a tube it gives off water and assumes a lighter color; if ignited in contact with the air it assumes a brick red. Alone before the blowpipe infusible; with borax it gives a clear bead colored by iron; with salt of phosphorus it gives a globule, orange yellow when hot, which on cooling becomes purplish-gray and opaque.

It is but slowly acted upon by hydrochloric acid, even when aided by heat; but concentrated sulphuric acid readily decomposes it by the assistance of heat, forming a grayish mass.

Qualitative Analysis.—A. A portion of the mineral in fine powder was mixed with sulphuric acid, in a platinum crucible, and covered with a plate of glass; a gentle heat was applied for half an hour when the color of the mineral had become yellowish-gray. During this operation the glass plate was not sensibly corroded.

B. A *large quantity of water* was now added to the acid mass, when a brownish powder separated, which by renewing the treatment with sulphuric acid became quite white, and was nearly soluble in a solution of carbonate of soda, showing that it was principally silicic acid; this was confirmed by fusing a portion of it with carbonate of soda, and dissolving the fused mass in dilute hydrochloric acid, when flakes of gelatinous silicic acid separated.

C. The solution from B was boiled, when titanic acid was abundantly precipitated. After long ebullition the liquid was filtered, (excluding as much as possible the air,) and by farther concentration reduced to a small bulk; it had a delicate green tint and was found to contain protoxide of iron, with a mere trace of peroxide, which probably arose from a slight absorption of oxygen, and the iron in the mineral was consequently supposed to exist as a protoxide.

D. After peroxidation by nitric acid, the solution was precipitated by ammonia: the filtrate was not affected by sulphuret of ammonium, it gave with oxalate of ammonia, a slight precipitate of lime, but with phosphate of soda and ammonia an abundant one, of phosphate of magnesia and ammonia.

E. The precipitate by ammonia was redissolved by a little dilute sulphuric acid, several crystals of sulphate of potassa were added, and the whole allowed to stand for twelve hours; at the end of this time a large quantity of crystals had formed, which were however completely dissolved by a saturated solution of sulphate of potassa. This showed the absence of cerium and lanthanum, as also of thorium and zirconia. An excess of pure potassa was then added to the solution, the whole digested for some hours and then filtered.

F. The filtrate was neutralized with hydrochloric acid, when carbonate of ammonia gave an abundant precipitate of alumina.

The precipitate by potassa was dissolved in hydrochloric acid, and after being largely diluted and rendered quite neutral, succinate of ammonia was added; the whole was then heated nearly to the boiling point, and as soon as it had cooled, the solution was filtered. These precautions were taken to prevent the precipitation of yttria, which it was thought might be present; the filtrate was evaporated to a small bulk, feebly acidulated by hydrochloric acid, and oxalic acid was added. This gave no precipitate, even after the lapse of several hours; yttria was therefore absent.

A portion of the mineral was fused with carbonate of soda, and dissolved in hydrochloric acid; sulphuretted hydrogen passed through the solution gave no precipitate, proving the absence of *tin*.

Having determined that the only substances present were silicic and titanic acids, with iron, magnesia, alumina, water and traces of lime, I proceeded to determine their proportions.

Quantitative Analysis.—1. A. One gramme of the mineral previously dried at 250° Fahr. and cooled in a dessiccater, was mixed with sulphuric acid in a platinum crucible; heat was applied and the digestion continued for half an hour; the whole was then allowed to cool, when water being added, a white residue remained. The fluid was carefully decanted off, and more sulphuric acid added, it was then heated till the acid began to be volatilized, cooled and the soluble parts removed by water; this process was repeated five times; the residue, which was silicic acid, weighed = ·185 grammes.

B. The solution was mixed with tartaric acid and ammonia in excess; the iron was then precipitated by sulphuret of ammonium, and when converted into peroxide, it weighed ·130 grammes.

2. A. Five decigrammes of the dried mineral treated as above, gave ·095 grammes; which when treated with carbonate of soda, left a little titanic acid.

B. The solution was precipitated by ammonia and the precipitate redissolved in the smallest quantity of dilute sulphuric acid, the solution being largely diluted with water and boiled for some time, adding water occasionally to supply the loss by evaporation. It is difficult to precipitate titanic acid by ebullition when the solution contains a large excess of sulphuric acid, but if the quantity of the solvent acid is small, the titanic acid is readily thrown down.

After four hours of ebullition, the solution was filtered and the titanic acid washed with a dilute solution of sulphate of ammonia and ignited; the crust which obstinately adhered to the glass, was removed by a few drops of sulphuric acid, with the aid of heat, and then thrown down by ammonia. The whole amount of titanic acid after ignition = ·132 grammes.

C. The filtrate was then evaporated to a small bulk, (during which operation no more titanic acid fell,) transferred to a platinum capsule, and digested for some hours with an excess of pure potassa. The mixture was then filtered, and the filtrate being neutralized by hydrochloric acid, carbonate of ammonia was added to precipitate the alumina, which, when ignited, weighed ·0692 grammes.

D. The residue of iron from the potassa solution, was dissolved in hydrochloric acid and precipitated by ammonia; after ignition it weighed ·074 grammes. The excess of weight over that of the iron previously obtained, (= ·018 grammes,) was owing to a little titanic acid not precipitated by boiling, and must consequently be added to the weight of the acid obtained.

E. The ammonical filtrate from B was treated with oxalate of ammonia, a precipitate of oxalate of lime fell, which was converted into sulphate, and was equal to ·013 grammes of pure lime.

F. The filtrate from E, was concentrated and mixed with phosphate of soda and ammonia, after twelve hours the granular precipitate was collected, washed with water containing a little ammonia, dried and ignited; it weighed ·303 grs. = ·111 grammes of magnesia.

G. The water was determined by heating to whiteness, in a covered crucible, three decigrammes of the carefully dried powder of the mineral. The loss was equal to 7·35 per cent.

We thus obtain from 100 parts—

Silicic acid, ...	18·5
Titanic acid, ...	28·2
Protoxide of iron, ...	10·59
Magnesia, ...	22·2
Alumina, ...	13·84
Lime, ...	1·3
Water, ...	7·35
	101·98

Henri Rose in a late memoir* has made it probable that the titaniferous irons contain a titanic oxide (Ti_2O_3) analogous to the

* Annal. de Chim. et de Phys., tome xv, Nov. 1845, p. 290.

sesqui-oxide of tin, and isomorphous with the peroxide of iron; and the same view is advocated by von Kobell.* This oxide is the blue compound which is formed when we digest a solution of titanic in hydrochloric acid with metallic copper; it forms a blue solution from which the oxide is precipitated by ammonia or carbonate of lime as a bluish black substance, which rapidly absorbs oxygen and becomes titanic acid.

It is however difficult to prove the existence of this oxide in titanic iron by actual experiment, as it is found that if we boil the blue solution of the sesqui-oxide or rather the sesqui-chloride, with per-chloride of iron, the iron becomes reduced to the state of proto-chloride, while the titanic oxide is converted into titanic acid. A similar reaction may be supposed to take place in the solution of the mineral, and hence we obtain as the result, titanic acid and protoxide of iron.

This theory of the composition of titaniferous iron, is the only one which satisfactorily explains its isomorphism with specular iron. Mosander ingeniously suggested in explanation of this fact, that a titanate of iron ($Ti\ O_2\ Fe\ O$) existed in these minerals, which was isomorphous with peroxide of iron, but we know of no instance of isomorphism between two bodies, one a salt and the other a simple oxide. If however we admit the existence of this titanic oxide, it can from its isomorphism, crystallize with any proportion of peroxide of iron.

I would suggest that the titanium in this mineral, exists in the form of titanic oxide, and the following reaction seems to favor this view. In an attempted analysis, a portion of the powdered mineral was mixed with sulphuric acid in a small flask, and digested for some time at a gentle heat; the mixture formed a solid crust on the upper part, but on the under surface next to the glass, a *beautiful ultramarine blue tint appeared*, which however disappeared on the addition of water. It was I think due to the presence of oxide of titanium, and did not the scarcity of the mineral forbid, I would make more extended experiments, to determine with certainty the nature of this curious reaction.

Admitting that this is the state of the titanium in this mineral, and that the iron consequently is a peroxide, we have for its composition:

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* Annal. de Chim. et de Phys., tome xv, Nov. 1845, p. 321.

Silicic acid,	18·5
Peroxide of iron,	13·0
Titanic oxide,	25·156
Alumina,	13·84
Magnesia,	22.2
Lime,	1·3
Water,	7·35
	101·346

Which proportions correspond closely to

Silicic acid,	8 equiv.	8	1
Peroxide of iron,	3 "	=16	2
Oxide of titanium,	7 "		
Alumina,	6 "		
Magnesia,	23 "	=24	3
Lime,	1 "		
Water,	16 "	16	2

In determining the chemical formula for this mineral, it is probable that we must regard the oxides of iron, aluminum and titanium, united, (as isomorphous bodies are known to be,) in quantities which are not necessarily in the ratio of their equivalents. It will be seen that the numbers 3, 7, and 6 do not accurately express the equivalents of their respective substances, but the excess in one is precisely made up by the deficiency of another, so that the sum of their equivalents is just 16; or dividing all the numbers obtained by 8, it equals two equivalents. The formula derived from this is, $2(\dddot{\mathbf{F}}e\ \dddot{\mathbf{T}}i\ \dddot{\mathbf{A}}l)+\dot{M}g_3\ \dddot{S}i+2\dot{H}$. The small quantity of lime doubtless replaces a portion of the magnesia. The following result was obtained by calculating the quantity of two equivalents of the oxides mixed in the proportion in which they really occur.

	Calculated.	Found.
Silicic acid,	18·000	18.500
Oxide of titanium, Oxide of iron, Alumina,	51·810	51·996
Magnesia,	23·115	22·200
Lime,	1·360	1·300
Water,	6·813	7.350
	101·138	101·346

This mineral is interesting as differing very much from every titaniferous mineral hitherto analyzed, in containing water. This fact connected with the presence of a silicate of magnesia, suggests the idea that it is an altered mineral, which finds additional support from its locality and associated minerals. The magnesian limestone in which it occurs, often contains crystals having the forms of spinelle and pyroxene, but converted into a soft hydrous mineral resembling steatite, a change which has evidently resulted from the introduction of a silicate of magnesia with water. If the mineral under consideration was originally a compound of oxides of titanium and iron with perhaps alumina, we should expect the form of the crystal to be a rhomboid like that of *specular iron* or *ilmenite*. Our present knowledge of the laws of pseudomorphism, appears inadequate to the decision of this question.

Yale College Laboratory February, 1846.

Art. V.—*Observations on the Geology of a part of East Florida, with a Catalogue of Recent Shells of the Coast;* by T. A. Conrad.

Having devoted some attention to the Tertiary formations of the Atlantic coast, I have endeavored to ascertain their relation to European formations. With regard to the Eocene of particular localities, no difficulty was experienced, because all the species of shells were extinct, and yet no Cretaceous forms or characteristic genera, such as Baculites, Hamites, &c., occurred in those places. This fact alone was sufficient to indicate the Eocene origin of the strata in question, but when such shells as Cardita planicosta, Corbis lamellosa, Ostrea bellovacina, and others equally characteristic of the European Eocene, were found in company with many species having a close affinity with shells of the Paris basin, the evidence was perfectly conclusive. The upper series of Tertiary strata, I have ever regarded as equivalent in stratagraphical position, to that portion of the English crag which contains Voluta Lamberti and Isocardia rustica, and whilst that formation was referred to the Older Pliocene, the term was used to distinguish the American equivalent. The error was one of terms alone, and has long since been corrected. I have explored the shores of the Gulf of Mexico, and employed the lead to procure the small species living in deep water, to compare the existing fauna with that of the Miocene period, and the result is that of three hundred and forty seven species, about forty seven are yet living, making about fourteen per cent. of recent species of shells; this accords with European Miocene strata sufficiently near in the per-centage of existing testacea, so far as such evidence is available, to establish a synchronous origin. This conclusion is confirmed by the close resemblance of the two groups of fossils, though the species are generally distinct. A considerable number of identical forms will no doubt be discovered when our collections shall be more complete. I have a small Corbula from Dax, which cannot be distinguished from C. inequale, Say, of the Virginia Miocene, and even this evidence of contemporaneous deposition, slight as it may seem, has force and interest for any one who carefully compares the fossils of remote formations.

With these introductory remarks, I proceed to give a slight sketch of an expedition to Florida in the winter of 1842, made in reference to new observations on Tertiary formations. A surveying expedition under Capt. Powel having been ordered by the Secretary of the Navy, Mr. Upsher, I was kindly permitted to join the steamer Poinsett, destined for the survey of Tampa bay. It was through the interest of members of the National Institute that I went on behalf of the Society, in order to furnish its cabinet with specimens of the rocks, fossils, and recent shells of Florida. As I have not yet had access to the specimens I sent the Institution, my slight sketch of Tampa bay and the Florida Keys is more imperfect than it would otherwise be. Supplementary observations will, however, in future be published, with a list of such fossils as I found on the Keys. In an expedition of this kind, too little time is afforded to study any one locality thoroughly, but the many points at which we landed, afforded a good opportunity, seldom enjoyed, of observing the geographical distribution of the more common species of shells inhabiting the northern coast of the Gulf. During a stay of three months upon the Florida coast, those species only were obtained which can be identified with supposed extinct forms of the Miocene period. The per-centage therefore of the recent shells of that era is scarcely modified by these new researches, and it is not likely that it will be by future explorers.

The first point at which I commenced my observations, was at Savannah, the site of which, was once an arm of the sea or bay, flowing over the land which now constitutes the extensive rice plantations bordering the river. This submergence was in the Post-pliocene period and the evidence is derived from shells, of recent species, some of which have been thrown out of the sandy bed of the canal near its junction with the river. These consist of estuary shells, common in all the brackish waters of the southern states, and which are indicated in the following list: *Littorina irrorata*, Say; *Solecurtus caribæus*, Lam.; *Cyrena carolinensis*, Bosc; and *Ostrea virginiana*, Gmel. A bed of the latter with the Cyrena intermixed occurs a few feet above the level of high tide. The water at Savannah is fresh and none of the foregoing species live therein. Several species of Unios occur in the river and canal; the most common are *U. Blandingianus*, Lea, which is probably a variety of *U. carolinensis*, Bosc; *U. subinflatus*, Con.; and *U. Shepherdianus*, Lea.

In ascending St. Johns river, Florida, we passed a bluff on the right bank, about twenty feet high, in which appeared, a thin, very much undulated bed of shells, which proved to be a stratum of *Ostrea virginiana*, as I ascertained by a subsequent hasty visit to the spot. It was at an elevation of ten or fifteen feet above high tide. This Post-pliocene deposit, taken in connexion with those of similar age on Tampa Bay, prove a considerable elevation of the whole Florida peninsula in the Post-pliocene period, a movement which clearly has raised all the Florida Keys above water. The steamer having been beached to repair damages received on St. Johns bar, I had ample time to collect the shells near the village of Hasard a short distance above the sea. There is here a gently sloping sandy beach not rich in shells, which are few in number both of specimen and species. The most abundant shell is *Mactra lateralis*, Say, which inhabits the whole coast from this point to Massachusetts, and is also common on the Keys at Tampa bay. It is also very numerous in the Post-pliocene of Maryland and North Carolina, and occurs more rarely in the Miocene of Virginia. The species near the mouth of St. Johns river are as follows:—

Bivalves.	
Ostrea virginiana.	Cardium magnum.
Pinna ———.*	Lucina divaricata.
Mytilus edulis.	Petricola dactylus.
——— cubitus *Say.*	*Univalves.*
Tellina lateralis, *Say.*	Ranella caudata, *Say.*
Amphidesma equalis, *Say.*	Crytostoma perspectiva, *Say.*
Mactra lateralis, *Say.*	Crepidula plana, *Say.*
Solecurtus caribæus.	Littorina irrorata, *Say.*
Arca pexata, *Say.*	Oliva litterata.
A. incongrua, *Say.*	Fulgur carica.
A. ponderosa, *Say.*	F. canaliculata.
Donax variabilis, *Say.*	Natica duplicata ?

All of these, except *Fulgur carica* and *Solecurtus caribæus*, I found subsequently at Tampa bay.

About half a mile from the river, I observed sand hillocks covered with bleached oyster shells, among which I found some specimens of *Arca pexata*, and a water worm *Gnathodon truncatus.* This is a marine Post-pliocene deposit, which corresponds with the estuary bed of Ostrea virginiana alluded to as occuring in the bank of St. Johns river. The living Gnathodon I was unable to find here, and I am persuaded does not exist in this part of Florida.

One of our officers landing at Fort Lauderdate, found a specimen of *Tellina radiata.* I presume this is about the northern limits of this beautiful but common bivalve.

Having landed at Key Biscayne to take in water, I had time for a short walk, during which I observed myriads of the *Polygyra plicata*, Say, in most places near the beach.

On Indian Key I was first made acquainted with the geological structure of this chain of small islands, which border the eastern and southern coast of the Florida peninsula. This island contains only eleven acres, and is composed of a Post-pliocene limestone, which in places seems little more than a cement for myriads of shells of such species as live in the waters of this latitude, and which are generally identical with those of Cuba. The rock on many parts of the shore is hard and full of large cavities, which are lined with four species of Nerita,† and myriads of *Littorina muricata* traverse the bare rocks far above the limit of

* A spinous species common in Tampa bay.

† *N. peloronta*, *N. tessellata*, *N. versicolor*, and *N. pica.*

tide water. Within a short distance is a much larger island and more elevated, with a dense forest except a narrow strip of cleared land which extends quite across the key, (here about half a mile in width,) planted with orange, lime, and other fruit trees. I found here the *Succinea avara*, Say; *Polygyra plicata, P. septemvolva*, and *Achatina fasciata*. Along the shore I observed *Spirula Peronii, Janthina fragilis, Carditomera floridana*, &c. Among the fossils, I found *Lucina tigrina, Strombus pugillus*, &c., and as I have not the specimens at present to refer to, I am compelled to defer my list of the Post-pliocene shells of the Keys.

These Keys are numerous, all having a similar origin and differ only in size and shape. They are situated in some of the most beautiful sheets of water that adorn the shores of any continent. Around Indian Key the different colors of the shoals were depicted on the surface of the unruffled water, and the tints heightened by the rays of the declining sun, were inconceivably beautiful. This halcyon sea is bordered by a long line of coral reef, and is navigable for small vessels; but in places the intricate channel demands a skillful pilot. The Poinsett by some accident got out of her course and grounded on a coral bank. We had been some time running in water so shoal that the bottom was distinctly visible, and when we struck I observed variously colored *Gorgonias* and white *Madrepores* which strongly reminded me of a flower garden, beneath the clear water of this shallow sea. The weather was beautiful, and the novelty of the scene united to its extreme lovliness made an indelible impression on my mind. I have no doubt the islands all rest on coral reefs, and their elevation above the sea is due to the movement which has raised the Post-pliocene of the peninsula.

Key West, one of the largest of the group, is a well known spot. Cocoa nut trees grow in the streets of the village, back of which seems to be an interminable forest. A variety of sponges line the beach, and many of the shells of Cuba occur here. East of the town in the shallow cavities of the rock, I found *Fasciolaria tulipa, Nerita peloronta*, and abundance of *Fusus corona*, Lam., some in the water and others in the moist limy earth, which in places covers the rocks. West of the town is a sand-beach, no rock appearing, and upon this several forms of cup-shaped and other sponges are very abundant.

Strombus gigas is common here, but it is not found so far north as Tampa bay.

Leaving Key West we soon arrived at Tampa bay on the western side of the peninsula, and here the surveying duties of the expedition commenced. We visited frequently many of the Keys which stretched across the mouth of Tampa bay, and several points on both sides of the bay, and in every locality I collected all the species of shells I could find, in order to study their geographical distribution. The shells are not generally very abundant on the island beaches, but on Mullet Key, whose eastern shore faces the bay, there is an immense accumulation of bivalves, about four feet in depth, the decaying animals of which render the atmosphere quite offensive. The most abundant shell is *Ninus cancellata*, Lam., which has generally both valves united, and the whole deposit is remarkably like that of a pliocene formation. Near this shore is the principal entrance to Tampa bay. On the northern beach of this island, I found *Chama arcinella* and *Strombus pugillus* far more numerous than any where else. While on Mullet Key we find so many bivalves entire, on Palm Key, a long island the most southern of the group, there is a very wide beach seaward upon which are comparatively very few shells and in bad condition. On the bay side the shells are more numerous, water-worn, and with separated valves. The most abundant shell is a species of Mactra like the *M. solidissima* but smaller. Passage Key has a similar group of shells. On North Passage Key immense numbers of small testaceous fragments line the beach.

On Egmont Key I found a solitary specimen of *Natica canrena*. *Pecten dislocatus* is very abundant here. Nearly all the bivalves are disunited at the hinge and water-worn; the surf rolls in a quick succession of waves, which soon injures such shells as may be cast ashore alive.

The shores of Tampa bay present a range of level land, densely wooded with pitch pine and the usual undergrowth of palmettos, but rarely a live oak or other tree of great size. Frequent clumps of mangroves are seen, with their dark green foliage and rugged irregular trunks and roots, the front rank standing in the water, generally dead and picturesque in appearance. High-water mark is defined by a line of sea-weed and other marine substances. Under this mass of vegetable matter, numerous small shells of various genera may be collected. We observe here several of the common bivalves which live as far north as Massachusetts. Beds of Modiola demissa are planted about the Mangrove roots; Cardium Mortoni is profusely scattered over the flat muddy shore; Osteodesma hyalina is not uncommon; Pecten concentricus, Anomia ephippium, Balanus ovularis and some other northern shells abound here; but the greater proportion of species are limited to the southern coasts of the Union. Along the water's margin at low tide, the beautiful little Marginella conoidalis crawls slowly upon the surface of the mud. It is accompanied by a far more abundant univalve, Nassa vilrx of Say, which appears in constant motion, like its neighbor. Upon the flat muddy shore, which has a great breadth when the tide is out, live great numbers of that beautiful coronated univalve, named Murex corona by Linnæus, which also seems very partial to oyster beds, and preys upon the animal of Ostrea virginiana. I found here a rare variety of the shell with a double row of spines. The character of this species seemed to me such as would place it in the genus Melongena of Sowerby; most certainly it is not generically the same with Fusus, Pyrula, or Murex to all of which it has been referred by authors. The most noticeable shells on these flats, are the gigantic Fasciolaria trapezium, Fulgur perversus, and F. pyrum. On the bars, nearly exposed at low tide, are beds of spinous Pinnæ and a gigantic species of Venus,* (V. Mortoni,) the shell of which weighs four pounds. Many specimens of Limulus polyphemus are scattered along shore. This crustacean has a wide range, as it inhabits nearly the whole Atlantic coast of the Union. On the grass, bushes and mangrove trees, as high as one can reach, great numbers of the elegant Littorina angulifera live and feed upon the leaves. Many of the shells of the bay shores seem to be confined to the bay, as I never observed them on the sea beaches of the Keys, and yet some of these species inhabit Long Island Sound and the waters about Newport and Boston. It would be interesting could we discover which locality was first colonized by such species, but we know not any clue to information of this kind.

The soil around Tampa bay is sandy and barren, filled with the projecting thick roots of palmettos, and not worth the labor

* V. mercenaria does not inhabit the waters of Florida.

of clearing for cultivation. Rocks are visible in only a few places, the principal of which is Ballast Point near Fort Brooke, at the head of the bay. This point has been much resorted to for procuring chalcedony of unusual beauty, formerly very abundant, but fine specimens are now rare. It coats masses of coral, a species of *Astrea;* which are derived from a Tertiary limestone, rising on the shore a few feet above high tide, and containing many casts of bivalve shells and much silicified coral, which when broken exhibits a cavernous interior lined with chalcedony and sometimes with quartz crystals. Masses of chert are also very abundant in this rock; it contains casts and shells of bivalves and univalves, differing from any I have observed in other rocks. They appear to be extinct species, and are, I believe, referrible to the Eocene period; most probably to an upper division of that formation. I traced this rock to the Falls of Hillsborough river, nine miles above Tampa. It is here very full of casts and impressions of shells of species unknown to me. It forms the basis in this vicinity of the pine and hammock lands, and from the large admixture of fragments of the rock* with the soil, and the many masses of silicified coral scattered over the ground, it is evident that the surface is nothing more than the disintegrated rock with just enough vegetable matter to nourish the trees and plants which grow thereon. In this spot, where there is so much lime in the soil, the pines are very lofty. There seems to the eye very little difference between the hammock and pine soils, both being light, sandy and unproductive. The poverty of the best fields I observed here is scarcely redeemed by the salubrity of the climate. On the Manatee river which enters Tampa bay on the southeast near its junction with the Gulf of Mexico, there is a range of hammock land about fifteen miles long. The settlers here have a good opinion of the soil and propose to cultivate sugar and tobacco. These hammocks depend upon the presence of the Florida limestone, which is certain to be the basis of the soil where live oaks grow, except in limited localities along the shores of bays and rivers where the Post-pliocene formation of shells affords the lime which seems necessary to the growth of that tree in this region of barren soils. Of this formation there are two bluffs on the bay near Sarasota Point, as it is termed,

* I found here an extinct species of Bulimus; B. floridanus, Con.

which is a low sandy and narrow peninsula, forming the southern cape at the entrance of Manatee river. The bluffs alluded to present two short sections about fifteen or twenty feet high, and consist chiefly of beds of shells, some of which are water-worn and broken, and many retain much of their original color and markings. The shells lie in groups of species, in a kind of indistinct stratification. Many of them are water-worn, others broken, and the bivalves occur in separated valves. Bones of the *Manatus* are occasionally found in the bluff, and the living animal is not uncommon in the Manatee river. The shells of this deposit are as follows:—

Bivalves.

Modiola demissa.
Cytherea gigantea.
Pecten concentricus.
Cardium isocardia.
Ostrea virginiana.

Univalves.

Fasciolaria trapezium.
F. tulipa.
Fasciolaria distans.
Natica duplicata.
Murex ——, *Lam.* A recent species occuring on Mullet Key.
Strombus pugillus.
Melongena corona. (Fusus, *Lam.*)
Fulgur pyrum.
F. perversus.

The most abundant of these are *Pecten concentricus, Ostrea virginiana, Fulgur perversus, F. pyrum, Fasciolaria tulipa, F. distans,* and *Strombus pugillus.* The group is precisely the same with that now living in the water in the immediate vicinity, though the small shells which abound in the bay I did not observe among the fossils. The vicinity of Sarasota Point is very interesting to a geologist, in consequence of the presence of several mounds of shells, much resembling those of artificial construction, and which would deceive any unpractised eye. On examination, the structure of the mounds is too similar to that of the bluffs already described to indicate a dissimilar origin, although no doubt many of the loose shells scattered around were cast there by Indians, as this must have been a favorite haunt where fresh-water fish and oysters could all be obtained in great abundance. But the Indians, to procure the animal of the large "conchs," must have burnt or broken the shells, which in the interior of the mounds present no traces of injury or fracture, though they are often water-worn, and when this is the case they must have been dead shells deposited in the ancient waters of the bay. These mounds occur on the river just above Sarasota Point, in the vicinity of a large spring of dark colored water, about fifty yards from the shore, which is shaded by a live oak. Around, are large conch shells thrown into small heaps by Indians. A few acres are cleared in the vicinity, and a nursery of orange trees planted. The rest is pine forest with the usual undergrowth of palmetto. A short distance up the river there is a bed of Post-pliocene oyster shells, about eight feet above the level of high tide, and above these fossils a few live oaks grow. At the head of Old Tampa bay the shore rises abruptly in rounded hills, one of which is comparatively large, and they are all covered with live oaks and a profusion of vines. These hillocks are of the same geological character with those of Manatee, composed of shells with a sandy soil above them. On the shore I observed masses of accreted sand with oyster shells, and very perfect casts of the same, quite indurated. There is also a Post-pliocene bed of this species over the limestone at Ballast Point; and at Fort Brooke there is another deposit of shells of the same age, but consisting of estuary species, such as live in the entrance of Hillsborough river; the group is chiefly composed of *Cyrena carolinensis*, *Ostrea virginiana*, *Gnathodon truncatus*, *Fusus corona*, *Natica duplicata*, and *Neritina reclivata*, (Theodoxus, Say.) A limestone, apparently identical with the rock at Ballast Point and Hillsborough Falls, occurs a few miles up Manatee river in the bed of a rivulet. It is silicious and hard in places; sometimes friable and sandy. In it I have observed casts of bivalves, none of which seem to agree with recent species of North America. Of its range and extent I am ignorant, having seen it only in this spot. It is near the shore of a creek, having a very narrow entrance, but which widens above, and about one mile and a half up, contracts again; then expands into a beautiful basin, with tables of rock bordering the shore. This rock is fragmentary, hard, and contains pebbles and limestone concretions, shells, corals and sharks' teeth, and is much honey-combed by the water. I observed several specimens of an unknown *Pecten* imbedded in it. Above this is a buff colored limestone without organic remains, about one foot thick. This spot is the limit of tide water, and in the stream above, I found many specimens of *Neretina reclivata* of unusual size. Young alligators were sporting in the water under the overhanging ledges of the rocks.

At Stony Point on the east coast of Tampa bay are some black, water-worn bones of mammalia, and Capt. Powel found here a specimen of the large shark's tooth, (*Carcharias megalodon,*) a species occuring also in North Carolina.

One of the most remarkable places near Tampa is a large sulphur spring, eight miles up the Hillsborough river. About one hundred yards up a tributary, the spring boils up and fills a capacious basin. It is white sulphur water coming from the crevices of limestone and from twelve to eighteen feet deep, and so perfectly limpid that the incrustations of sulphur at the bottom are as distinctly visible as if the water were but an inch in depth. Just below the spring great numbers of mullets may be seen scudding in all directions as the boat passes over them, but not a fish of any kind seems to trespass upon the sulphureous basin.

In the fresh water of Manatee river, a large soft-shelled turtle is frequently caught by the settlers who prize it as an article of food. I inquired the number of claws on each foot, and was answered by a man who had recently caught one, that there are five claws to each foot, which verifies the accuracy of Bartram, who describes and figures an unknown species with this character, which must be very distinct from the common soft-shelled tortoise of the south, (Trionyx ferox.)

Since writing the preceding sketch of Tampa bay, I have examined more attentively the casts and shells contained in the limestone. None of these can be identified with any recent shells of Florida or the West Indies. But what has satified me that this rock is geologically older than the Post-pliocene, is the occurrence of an extinct species of land shells, a Bulimus which is silicified and extremely perfect. No similar species of this genus exists in North America. All the other shells in the rock are decidedly of marine origin, and very large masses of a new species of Columnaria abound. It is remarkable that the fossils of this rock have no near resemblance to those either of the Miocene or Eocene, and it will most probably prove to be an upper member of the latter. The local depositions of this formation vary much in their fossil contents. Those of the Santee river in South Carolina, are quite distinct from the group which characterizes the Eocene limestone at St. Stephens, Alabama.

I have obtained casts of a species of Venus; of Nucula, two; Cytherea, one; Natica, one; Bulla, one; Bulimus, one; and two Foraminifera, comprising a Nummulite and a Cristellaria. The latter multilocular shell can be obtained by pounding the rock into small fragments, when the shells fall out entire, and some of them can readily be seen without a glass.

The variations in the groups of shells may be in part owing to some difference in geological age, as the Eocene has unquestionably newer and older members, as well as the Pliocene or other formations. But depositions in different depths of water and on different kinds of bottom have also caused local variations in the fossil contents of Eocene rocks. Much light could be thrown upon this subject by a careful investigation of recent species inhabiting different depths of water along the coast. The Miocene, however, could be still better illustrated by this means, because the deep-water species are precisely those which most abound in the Miocene and are most rarely seen upon the beaches. Thus while sailing in the Gulf of Mexico, I watched with interest such specimens from the bottom as the lead brought up, and by this means I obtained a new Corbula, a specimen of Dentalium coarctatum, which I believe to be the first living one found this side of the Atlantic, although it is a common shell in the Virginia Miocene. I obtained also Cytherea elevata and Nucula acuta, which are likewise common in Miocene deposits. All these are deep-water species, living at the depth of eighteen or twenty fathoms, which I never found recent on the beach, and therefore they may fairly be cited as evidence of the fact that such Miocene localities as contain abundance of them, originated in water of similar depth. Other localities of Miocene contain quite different species, and beds of shoal-water origin can often be clearly made out. With regard to the Eocene, no doubt can be entertained that similar causes have produced similar effects. I hope to make out a line of demarcation between the older and newer strata of the Eocene period that may be convenient in the study of this formation. Thus I propose the Nummulite limestone of St. Stephens and Clark county, Alabama, and the fossilliferous bluff at Claiborne, as Lower Eocene, inasmuch as they hold a few species intimately related to, if not identical with, cretaceous forms, and so far as we know, all the species are extinct. The limestone of Savannah river in Georgia, between Savannah and Shell bluff, contains two recent shells, Lithodomus dactylus and Trochus agglutinans, and is evidently a later deposition than the former rocks. I propose to term this, Upper Eocene, and very probably the prevalent limestone of Florida will be included in this division.

This rock extends throughout the peninsula, as far south at least as Tampa bay; and both the east and west shores of this peninsula are covered with a Pleistocene formation of recent species of shells and remains of mammalia. The elevation of East Florida above the sea level is so inconsiderable, that all or nearly all of it must have been submerged at the time the Post-pliocene species were existing, and therefore its elevation was contemporaneous with that of the Keys, which line its eastern, southern, and western coasts.

ART. VI.—*The Physical Structure of Plants;* by D. P. GARDNER, M. D., formerly Professor of Chemistry and Natural Philosophy in Hampden Sidney College, Virginia.

1. THE composition of the earth's atmosphere is the result of great physical laws, which acting in all places produce an uniformity of structure of the highest interest and importance. Whatever cavities or porous systems lie in this medium are subject to its laws, and the same forces which produce the diffusion of gaseous volumes into the air, govern their penetration throughout membranes. The movement into a cavity, and the escape of aëriform matter come to an end after a time, and there remains a similar atmosphere within, and around the exterior. So true is this that whatever gases are confined in porous bodies, pervious tissues, or fissured vessels, will sooner or later acquire the composition of the common atmosphere.

2. Botanists in studying the phenomena of plants, have hitherto been too much attracted by those of the highest development, in which a complex machinery of spiral vessels, laticiferous ducts, and other additional organs exist. The office of these parts will undoubtedly be resolved in time, but unless we first comprehend the general functions, the uncertainty which now exists in vegetable physiology will remain undispelled. The green mildew of damp walls, *Chlorococcum vulgare*, offers us an instance of an elementary plant, consisting of a single cell, which is nevertheless possessed of all the essential qualities of a vegetable. Within its limited dimensions are stored the forces of growth; the ability to decompose carbonic acid for the production of amylaceous matters—within its one wall the azotized products are formed

and seeds perfected. To enter this organism, gases must penetrate the bounding tissue, and whatever elastic products are formed by chemical decomposition must find exit. But however readily some might admit the porosity of this inferior vegetable, most botanists are disposed to look to a recondite principle, a vitality, for the solution of physiological points. The influence of ordinary penetration in plants has never been proved, although conjectured by Liebig, Dumas, and the more speculative chemists, on the contrary the only direct series of experiments made on the subject by Messrs. Ferrand and Calvert, (Ann. de Chim. &c., August, 1844,) led those gentlemen to the opposite conclusion. They assert, at page 485 of their memoir, that "the bladders of *Colutea arborescens* are not permeable to the air except in the most limited degree." In the case of *Clorococcum* the penetration of gases is not only an essential point but nearly the only physical phenomenon, the other processes of growth and decomposition of carbonic acid, &c., being effects of this in a great degree. Now there is little doubt that the organic forces of this plant are those of the whole vegetable kingdom; hence to prove that the structures of other plants is identical with this, is to show that all are reducible in their essential functions to a system, subject to physical penetration, and this is the object before me. I propose to discuss this position under the following heads:—

1st. The bounding membrane of plants is porous.

2d. The nature of the internal gas of plants.

3d. The action of roots on the gases of the soil fluid.

4th. The absorption of gases by plants is a result of their porosity.

5th. The action of plants upon artificial atmospheres.

I. *The bounding Membrane of Plants is porous.*

3. The object here is to show that the epidermis is not merely capable of transmitting a gas of particular composition, but that it obeys the theoretical requisitions of a porous membrane. This is not indeed asserted of other plants than those employed, although I believe it to be a general law of the vegetable kingdom, the exceptions being inconsiderable. The bounding membrane of leaves is taken for experiment, because there exists no doubt of the free intercommunication within plants by the cellular spaces and other channels, and because it is obvious that if any

vital force or antagonism existed to the operation of the phyisical laws of penetration it would be situated at the threshold; over the exterior and not in the interior of plants.

4. The experiments were planned with the twofold object of showing that carbonic acid would penetrate into a vessel containing common air, notwithstanding the opposition of a barrier of vegetable epidermis, and secondly that an enclosed atmosphere of theoretical composition would solicit the passage of both carbonic acid and oxygen towards it, and at the same time throw out nitrogen gas. There was some difficulty in obtaining perfect specimens of epidermis from most leaves and the observations were limited to those plants which furnished it readily and were accessible.

5. *The experiments.*—August 6th, 1845, a tube five inches long and one third of an inch in bore was selected, and one extremity softened and pressed until it presented a thick ring of glass, this was next ground to a plane surface. This tube was depressed in a mercurial vessel to within an inch of the mouth, a portion of the fresh epidermis of the Madeira vine (*Bassilla lucida*) was then adapted to the ground surface by means of soft wax. The portion of membrane lying over the bore of the tube was circular and nearly a third of an inch in diameter. The tube was now raised up three inches from the trough and suspended by a wire; the membrane sustained the pressure of three inches of mercury without leakage. In about ten minutes sufficient clear limewater was introduced through the column of mercury to reduce its level to that in the vessel, so that the tube contained one inch of atmospheric air at the same pressure as that without, and three inches of limewater, and was closed above by vegetable membrane and below by mercury. Over this arrangement a small bell jar was placed containing atmospheric air with 10 per cent. carbonic acid. The experiment commenced at 1 o'clock P. M., temperature 81° Fah., and at 6 o'clock P. M. the limewater exhibited a distinct pellicle of carbonate of lime.

6. The carbonic acid therefore penetrated the epidermis. This experiment was made with slight modifications with the upper and lower epidermis of the Madeira vine, the epidermis of the cabbage leaf, the *Alanthus alata*, *Chenopodium album*, and several species of Sedum which are covered with a tough skin readily removed. Some leaves, as from the *Impatiens balsamica*,

furnished an epidermis that leaked so fast when the tube was raised from the mercury, that no experiments could be made with them, other specimens sustained for thirty-six hours a pressure of four inches and then became so dry as to crack.

7. August 12th.—A tube similar to the preceding, but with an aperture of one fourth of an inch and graduated, was closed by a piece of the epidermis from the under side of a cabbage leaf. It was filled with mercury, placed over the trough and 400 measures of a mixed gas, containing nitrogen 87, oxygen 13 per cent. introduced; there still remained two and a half inches of mercury. Over this was inverted a jar containing common air with 10 per cent. carbonic acid. The arrangement was completed at 2 P. M., temperature 83° Fah., and the mercurial column descended until 11 o'clock P. M. when the tube contained 433 measures, this remained stationary until 5 P. M. the next day, temperature 81° Fahr. The internal gas yielded on analysis, nitrogen 76, oxygen 17, carbonic acid 7 per cent. Therefore nitrogen had been evolved from the tube and carbonic acid and oxygen absorbed. The external mixture was not examined, as the object in view was merely to ascertain the mechanical penetration. The foregoing plants were also examined in this way and all gave similar results.

8. Variations were made in these two experiments to attain certainty, and the results were uniform when the same membrane was used. There was considerable difference in the rapidity with which gases penetrated the different specimens of epidermis. This fact is no doubt connected with the number and size of the stomata; and in the case of the balsam it was manifest, the epidermis being studded with them: but as this point did not specially occupy my attention I dismiss it without further remark.

II. *The Nature of the internal Gas of Plants.*

9. It having been shown that the bounding membrane is porous, the gases of the interior of the plant should apparently resemble the common atmosphere. But this is true only under one condition, that all chemical changes in the interior shall have been arrested for some time. It is obviously untrue in every case where organic movements are occurring, whereby some gases are absorbed and others decomposed, and this we know to be the condition of a living vegetable.

10. Several observations have been made on the gases contained in the cavities of plants, by Priestly, Davy, Ferrand and Calvert, Payen and others. But in all cases the collections have been in supernumerary organs, or such means have been taken for obtaining the gas as to interfere with the result. The examination has also been made without considering the effects of a porous epidermis, and the internal changes going on in the plants. It is obvious that the internal atmosphere of a permeable body, freely in contact with air, and with the gases of fluids or the soil, and which is moreover an apparatus of decomposition and other chemical actions must be ever fluctuating. The presence of light, its intensity, and the structure of the soil are disturbing causes.

11. Placing before me the above considerations, and the known fact that the gases evolved by growing plants differ in light and darkness, I considered in what way to obtain a knowledge of the *normal* atmosphere of active plants. It is not worthy of thought in investigating this question, whether the internal gases are separated into spiral or laticiferous vessels, or insulated cellules; it is probable there is an inner system of barriers, which in the higher vegetation is necessary to produce particular results, but in the lower classes this is absent, and therefore we might infer that there is a common plant atmosphere as well as a peculiar combination of gases within particular portions. The solution of the problem appears to rest in obtaining the gas diffused throughout plants whilst they are in a vigorous state, some time after the sun has been acting on them, and without mutilating the specimens before use, as nearly every observer has done. The gas of the plant should not be drawn out by the air-pump because the elastic fluids of the sap and of the closed vessels are obtained in this way and these are not sought after.

12. For the purpose of satisfying these conditions, I transplanted in May, 1844, several young plants of *Datura stramonium* and blue grass (*Poa pratensis*) into small tumblers and allowed them to remain three to six weeks before use, so as to be perfectly vigorous. Having completed my arrangements for analyzing minute portions of gas, by means of a sliding-rod eudiometer, I proceeded in the experiments after the following manner. The time of examination was about 11 A. M., after the plants had been fully exposed to bright diffused light, (June.) Two or more specimens being selected, the tumblers were placed in a small

tub containing sufficient water to just cover them and not interfere with the functions of the plants; by moving the water with the hand, it softened and washed out the garden mould of the tumblers, enabling me in a few minutes to remove each plant in a perfect state, without injuring a single spongiole. The plants were next introduced into a suitable pneumatic trough, washed free from adherent air by passing the fingers over every part, and then drawn under a receiver with a wide mouth, where they were rapidly broken and gently pressed so as to obtain the free gases of their interior; the stem and leaves both furnished gas. These manipulations were conducted as rapidly as possible and the gas obtained immediately analyzed.

13. The plan of analysis consisted of first passing the gas through solution of potash in a Kemp's tube, to ascertain the carbonic acid, then mixing with binoxide of nitrogen properly prepared for the occasion, to discover the oxygen, the resulting gas was examined for hydrogen and carburetted hydrogen in several cases but found to be pure nitrogen. The examination was completed in about three minutes, and no corrections for temperature, pressure, or moisture were necessary from the rapidity of the operations, and the whole being conducted in water of the same degree of heat. I confess my unwillingness to use the binoxide, but neither the eudiometers of Volta, Ure, or Hare could be employed with such small amounts of gas, and finally I became reconciled to this method by the excellent results which may be obtained with a little care. Each series of examinations was compared with an analysis of atmospheric air made immediately after, and in 25 measures I find that the average amount of oxygen is 20·83 per cent., from which it never varied 0·20 volumes; this result is equal to that of the elaborate analyses of Dumas and Boussingault, who obtained 20·8 per cent of oxygen.

14. *Experiments.*—Three analyses of the internal gas of the Datura plants, gave on the 15th of June, a mean of nitrogen 87·0, oxygen 13·0 per cent. with no carbonic acid, and on the 17th, three further examinations gave nitrogen 88·0, oxygen 12·0 and no carbonic acid.

Two analyses of the gas from grass plants on the 15th, gave a mean of nitrogen 84·2, oxygen 14·8 per cent., and on the 17th, nitrogen 88·0, oxygen 12·0 without carbonic acid in either case. An analysis by Dr. Draper published in the Philosophical Magazine, of gas obtained from grass by the air-pump, is precisely the same as in the second examination.

15. In these measures we discover a remarkable uniformity not only in the same species but in both plants. The mean of the six examinations with Datura gives an internal atmosphere of nitrogen 87·0, oxygen 12·5 per cent cent., and the four with grass a mean of nitrogen 85·5, oxygen 14·5, or a mean of the whole equal to *nitrogen* 86·75, *oxygen* 13·25. This we therefore assume as the normal or usual plant atmosphere at 11 to 12 A. M., and during vigorous existence in the presence of bright diffused light.

16. It is distinctly to be understood that the above or conditionally normal atmosphere is perpetually changing, and is true only for the time and place. In my preparatory examination of the subject I measured the internal gas of a specimen of grass as nitrogen 84·6, oxygen 13·0, carbonic acid 2·4 per cent., but overlooked at the time the circumstances of the analysis. Messrs. Calvert and Ferrand give, as the composition of the gas in the hollow stems of *Phytolacca decandria at night*, nitrogen 76·4, oxygen 20·6, carbonic acid 3·0 per cent.

III. *The action of Roots on the Gases of the Soil Fluid.*

17. The roots of plants present an absorbent surface which is probably little less than that of the leaves; a knowledge of their action is therefore indispensable to a proper understanding of the physical structure of plants. On this point nothing can be derived from the labors of others except that De Candolle (Physiologie, t. i, p. 248) asserts that uninjured roots exhale no gas either in light or darkness. Theoretically it is admitted by most physiologists that the entrance of fluids into plants by their roots is a process of endosmosis, but in regard to elastic matters we are left to infer that such find entrance as happen to be dissolved in the liquids of the soil, since no direct examination of this point has ever been made.

18. This inference that all the gases dissolved in the soil fluid penetrate into the interior of plants, can only be admitted under limited circumstances. Wherever the sap is already saturated with a given gas, further quantities will not be received; and again, the fluids of the plant may be electrically opposed to the penetration of a particular gas. The absorbent capacity of the

sap is likewise subject to the variations of light and darkness, and of chemical conditions. We cannot therefore reach any certainty by mere argumentation as to the action of roots on gaseous mixtures dissolved in fluids, and must resort to experiment for a solution of the problem. Our researches must also be directed to a given point, as shown in section 11, or we obtain no trustworthy conclusion.

19. *Experiments.*—On the 25th of June, 1844, I commenced a series of observations to determine the action of the uninjured roots of Datura and blue grass on the gases of common pump-water. The plants were obtained as directed in section 12, so that the roots were perfect. Each specimen when washed free from soil was introduced into a vessel of glass, of the figure represented in the engraving, and previously filled with pump-water. By this contrivance the gases evolved by the roots, if any, would rise into the upper part *a*, fresh water could be added to compensate for evaporation by the leaves, and the atmosphere be completely shut out. The plants of Datura were nine inches high, the grass plants about five inches. Three sets of plants were used, two specimens of each being placed in darkness, *A;* in diffused light with the glass uncovered, *B;* and thirdly with the leaves exposed to light but the glass vessel covered, the roots being in darkness, *C.*

20. On the evening of the 25th, the two plants of Datura, *B*, were placed in the study window so as to receive the morning light; at 11 o'clock the next morning there was sufficient gas in both vessels for analysis, (§ 13,) the composition of both was identical—nitrogen 96·9, oxygen 3·4, no carbonic acid. A test experiment with air gave 20·9 oxygen per cent. These two plants being uninjured and exceedingly vigorous were returned to the receiver, supplied with fresh water, and placed in a dark cupboard at 10 P. M. of the 26th, where they remained for thirty-six hours without evolving a bubble of gas. At 10 A. M. of the 27th they were again exposed to light, and yielded at 2 P. M. suf-

ficient gas each for three analyses, the mean of which gave, nitrogen 96·2, oxygen 3·8, without carbonic acid. Atmospheric air at the same time yielded 20·8 per cent. oxygen.

The grass plants *B* yield gas, but usually in such small quantities as to be unserviceable, but two examinations obtained gave, nitrogen 96·0, oxyn 4·0, without carbonic acid.

21. The two Datura plants *C*, with only their leaves illuminated, were exposed at the window on the evening of the 26th, and furnished sufficient gas at 11 o'clock the next morning for six analyses; the gas in both was similar, and gave a mean of nitrogen 96·5, oxygen 3·5 per cent., without carbonic acid.

22. Neither the grasses not Daturas furnished any gas in complete darkness, although the experiments were continued until the specimens were decomposed. We see however that an exposure to darkness for thirty-six hours did not arrest the vigorous action of Datura in section 20.

23. *Deductions.*—The foregoing experiments prove that the perfect roots of plants, so far as these specimens are concerned, appear to evolve gas, but in different amounts, and that the gas consists of nearly pure nitrogen and is very uniform in composition under the same circumstances. The exposure of roots to light or darkness does not seem to influence the result, but the action of light on the leaves is essential to the production of gas.

24. The gas collected in the reservoir was in some measure derived from the sides of the glass and did not appear to be emitted from the root, but was collected in minute bubbles over its fibres. The evolution did not however depend upon the mechanical action of light or heat, for the water in the darkened vessels and some placed for comparison without any plant did not furnish any. The composition of the gas is also opposed to this supposition, for by Prof. Morren's researches, (Ann. de Chim, &c., Sept. 1844,) it is shown that the sun's light liberates carbonic acid and nitrogen, accumulating oxygen in the water, a result very different from what occurred in these cases.

The gas contained in pump-water and separated by boiling, was nitrogen 48·0, oxygen 22·0, carbonic acid 30·0 per cent. The root acting on this mixture disturbed its composition by absorbing the carbonic acid and most of the oxygen present, hence causing the water to abandon the nitrogen for which it has but a feeble affinity. Therefore we may conceive that every cubic millimeter of pump-water absorbed, gave up its nitrogen as an elastic body instead of carrying it into the sap of the plant; the gas thus liberated being nearly insoluble in the remaining fluid, rose through it into the upper part of the receiver. It is even probable that the roots gave off no gas whatever from the sap.

25. The experiments show that plants do not merely absorb the gases dissolved in water, as is usually imagined, but that their action is regulated by internal functions, for during night or darkness, the water, with its gaseous contents undisturbed, is absorbed, but during the active condition of vegetation a selection is made of carbonic acid chiefly, and that oxygen is also absorbed, whereas in all probability every molecule of nitrogen is rejected.

IV. *The absorption of Gases by Plants is a result of their porosity.*

26. We are now in possession of sufficient data to state the case. A porous system lies between two media and contains a certain internal atmosphere; the gaseous composition of these three are as follows:—

	The air.	The plant gas.	The water gas.
Carbonic acid,	0·05	0·00	30·0
Oxygen,	20·80	13·25	22·0
Nitrogen,	79·15	86·75	48·0
	100·	100·	100·

If the mixture designated the plant gas, were confined within an extremely delicate caoutchouc bag and surrounded by either the water gas or atmospheric air, it would soon be disturbed by penetration, nitrogen would be slowly eliminated and carbonic acid and oxygen absorbed. The rapidity of the movement would depend on the gas and also the character of the membrane. So much for the physical consequences; we now proceed to examine what really takes place in the case of plants.

27. The action of the roots on the water gas existing in the soil, and represented by that in pump-water, is given at length in the last division of the memoir; as there are no experiments on the subject accessible to me I must advance my own in confirmation of the correctness of the physical theory. In M. Boussingault's Economie Rurale, it is stated that M. Piobert found that roots absorbed nitrogen, but as I have not seen any evidence of this I cannot admit it in opposition to my experiments.

28. But that there might be no doubt on the action of a porous vegetable tissue, such as envelops every part of plants, when containing an atmosphere similar to that called the plant gas, and surrounded by a mixture resembling the water gas, the experiments detailed in section 7 were contrived. The results in these cases were directly coincident with theory. If it be admitted that the epidermis employed resembles the tissue of the roots, the consequences must also be admitted. That the tissues are analogous and would act in the same way may be inferred from the observations of M. Payen, who maintains that the enveloping cellular tissue of all parts of plants (*cellulose*) has a definite composition; and if the chemical nature be the same, the affinity for different gases and fluids will be identical. There is but one other disturbing cause, which we cannot enter upon in this place, —the affinity of the gases and fluids stored within cellules and closed vessels. Now the bounding membrane of a cell may exert an attractive force towards a given gas or fluid, which, notwithstanding, never penetrates to the interior because of the antagonism of the included substance, which does not combine with it, and therefore the passage is arrested at the internal limit of the membrane. Whatever effect may arise from this or any other cause in the complex processes of the higher vegetation are not before us now; the absorption and evolution of certain gases by plants is the resultant of all the internal actions, and with these only are we concerned.

29. If we consider the action of leaves on atmospheric air, the theory of physical penetration is more certainly established. In this case we find oxygen and carbonic acid absorbed and nitrogen liberated in the same way as in the experiments in section 7, where the plant gas, nitrogen 87·0, oxygen 13·0 per cent., was brought in contact by a piece of epidermis with a mixture of common air and ten per cent. carbonic acid. With living plants the experiment has been made by the most skillful observers, as Saussure, Davy, Daubeny, and others. In Saussure's researches nitrogen was always evolved, whilst carbonic acid and oxygen were absorbed. It is not indeed admitted by all vegetable physiologists that oxygen is uniformly absorbed and nitrogen thrown out during the growth of the green parts, but upon examining the best experiments these facts will be found abundantly confirmed. Saussure always observed the evolution of nitrogen, whether the plants were immersed in air or water. De Candolle,

Palmer, Daubeny, and Draper, also sustain this position. The uniform absorption of a portion of oxygen by the plant, is proved by the researches of Gough, Achard, Scheele, Cruickshank, Saussure and others. Gough showed that an atmosphere without oxygen was incapable of producing the green color of leaves by changing the yellow color of such as were raised in darkness, (*Manch. Mem.*, iv, p. 501.) This singular fact is now explained by the discovery of the nature of chlorophyl, which M. Preisser shows to be an oxydized product.

30. The absorptions taking place under the influence of light owe their continuance during the growth of the plant to its action. The gas entering, is destined to equilibrate the internal atmosphere and give it a composition analogous to common air, but this it is incapable of accomplishing because of the decomposing action of light. Hence a constant current of carbonic acid sets into the plant, the oxygen of which is partly employed in producing chemical results, and a deficiency of both carbonic acid and oxygen is consequently presented by the plant atmosphere, these two bodies being withdrawn by the organic changes faster than they penetrate.

31. It is only so long as the carbonic acid and oxygen are appropriated by chemical forces that the internal plant gas differs materially from common air. As soon as decomposition by the sun's light is arrested, the absorption of carbonic acid from the atmosphere ceases, and that portion which rises along the roots, is, according to Ingenhousz, in part thrown into the air. Oxygen is still absorbed for the production of special compounds. After a time, supposing the chemical affinities satisfied, the plant atmosphere has obtained an equilibrium with the air, and all movements cease. In Messrs. Calvert and Ferrand's experiments, the increase of carbonic acid during night in the plant gas is a constant feature, the oxygen also became equal to the proportion in air. Under these circumstances if the fluid absorbed from the earth be rich in carbonic acid, a portion will be evolved as soon as it has been conveyed by the sap into the plant atmosphere in excess. This condition may not be satisfied in one case, and no carbonic acid liberated, as found by Mr. Pepys, whilst in another, from the nature of the soil, the gas may be abundantly thrown out, as proved by Saussure, Ingenhousz, and others.

32. We are therefore justified in regarding a plant as a porous system, the normal or internal atmosphere of which has a com-

position resulting from the continued absorption of oxygen and carbonic acid during daylight. The deficiency thus caused as the first effect of the sun's rays, brings into operation the laws of diffusion. From the common atmosphere, carbonic acid and oxygen enter through the epidermis of the leaves, whilst the spongioles give passage only to such a gaseous mixture as is required by the sap. The gases thus finding entrance to equilibrate a deficiency, are in their turn decomposed or appropriated, at first by a decomposition of carbonic acid an excess of oxygen is produced, but a portion being evolved, the per-centage within is gradually diminished until it becomes less than that of the atmosphere. The same changes continuing during daylight, a stream of carbonic acid sets into the plant, whilst portions of its oxygen with nitrogen are liberated; oxygen with carbon being continually fixed by the plant. It is the unsatisfied equilibrium of the internal gases which originates and maintains the current.

V. *The effects of Artificial Atmospheres upon Plants.*

33. But to show more distinctly the mere physical porosity of vegetable tissues, we may examine the interesting observations of M. Marcet, which like many other similar facts remain unassimilated. This observer found (*Ann. de Chim., &c.*, t. lviii, p. 407) that the same species of fungi exposed to different atmospheres, as common air, pure oxygen, or pure nitrogen, gave off dissimilar gases. If we investigate these results, it will be seen that in each case the theoretical indications of a porous system are satisfied. The table gives a synopsis of the action of the same living fungi on the three atmospheres; in each case 100 volumes of the gas were used, and after the plants had been immersed therein eight to ten hours its composition was ascertained and found—

	Atmospheres.		
	Common air.	Oxygen.	Nitrogen.
Oxygen, . .	2·0	31·3	0·0
Nitrogen, . .	77·0	24·0	96·1
Carbonic acid, .	21·0	44·7	3·9
	100·	100·	100·

From the composition of the resulting gas, it is apparent that the plant atmosphere of these fungi contained a high per-centage of nitrogen and carbonic acid with a deficiency of oxygen, adopting this speculation the effect upon the three atmospheres coincides precisely with the result. There cannot be a more complete proof of the absence of any specific antagonism or vital force than is presented in these and similar experiments; the gases expired are distinctly the same as should flow out by exosmosis.

34. The property of evolving nitrogen in the families of fungoid Cryptogamia, associates them to the Vasculares, and shows that whatever points of difference may exist between these divisions of the vegetable kingdom in other respects, there is in this respect an uniformity of action of the greatest interest, as the chemical changes leading to the separation of nitrogen, belong to all living plants. The large absorption of oxygen in fungi is a prominent function, they do not appropriate it in the same limited way as other plants, but are even capable of decomposing water for its attainment, the hydrogen being liberated. This phenomenon has been witnessed by Humboldt, De Candolle, and M. Marcet.

35. In the researches of Th. de Saussure on germination, an interesting case of physical penetration occurs, which has produced some confusion among theorists. In the Memoires de la Societé Physique, &c., de Genève, t. vi, p. 545, it is stated that seeds germinating in common air absorb nitrogen gas; but that when the process is conducted in an atmosphere of equal volumes of nitrogen and oxygen, none is absorbed. This is precisely the result to be expected, on the hypothesis that the absorption of gases is a physical phenomenon: so long as the atmosphere without contains 80 per cent. nitrogen, this gas is absorbed to produce a compensation in the plant gas, but when it is reduced to 50 per cent. absorption ceases, the seeds and growing parts, containing a sufficiency in their pores.

36. How far confusion may arise in questions of vegetable physiology, if we overlook the physical laws of penetration, is made evident by the contradictory statements of Saussure, Ingenhousz, Plenk and De Candolle, on the absorption and evolution of gases by the green parts of plants placed in artificial atmospheres. Les parties verts laissent moins de gas oxigène dans le gas hydrogène que dans le gas azote; elles ne paraissent, contre l'assertion d'Ingenhousz, absorber ni l'un ni l'autre. Il parait aussi certain, malgré l'assertion d'Plenk, qu'elles n'exhalent point de gas azote, sauf dans quelques cas, par les corolles.—*De Candolle Physiologie Veg.*, t. i, p. 133.

37. Some observations made by me in the summer of 1844, also serve to verify the position, that the gases exhaled by plants are not constant, but depend upon the atmosphere in which they are plunged. Specimens of the *Conferva mucosa* were placed in pump-water, which is their natural medium, and others in distilled water impregnated with carbonic acid gas, and exposed to sunlight. In six hours the gases produced in the receivers were entirely separated, and the arrangement left for twenty-four hours without any fresh water; the gases were again withdrawn, and thus for four and five days, no fresh water being added throughout. It is evident that the gas of the water was constantly changing in its composition, and therefore the experiments were the same as if made in a number of different artificial mixtures of gases.

The plants in pump-water gave in the first six hours an expired gas, consisting of oxygen 73, nitrogen 27 per cent.; in twenty-four hours, oxygen 53, nitrogen 47 per cent.; in forty-eight hours, oxygen 18·6, nitrogen 81·4 per cent. The specimens in carbonated water produced in six hours, gas consisting of oxygen 68, nitrogen 32 per cent.; in twenty-four hours, oxygen 63, nitrogen 37 per cent.; in forty-eight hours, oxygen 12, nitrogen 88 per cent.; in seventy-two hours, oxygen 3·5, nitrogen 96·5 per cent. These latter were in no way injured at this time, for upon adding a little fresh fluid they yielded at ninety-six hours, a gas consisting of oxygen 15, nitrogen 85 per cent. The aliment of these plants was not changed, for they continued healthy, the different gases expired were merely the result of physical necessity, the aëriform matter of the water being continually changed. I do not assert that all the nitrogen in the foregoing measures was thrown out from the interior of the plants, because as we have already shown in section 24, the physical disturbance of the water gas will be attended with the evolution of nitrogen, and although distilled water was used, there is no process by which all its gas can be driven out.

38. *Conclusion.*—From the preceding evidence I infer that plants are a simple porous system, so far as they are related to the air and the gases of fluids in the soil, leaving out of consideration the internal phenomena of penetration. The advantages resulting from the adoption of this philosophical view of vegetation, both in assimilating facts hitherto insulated and criticising experimental arrangements in vegetable physiology, form its great

recommendation. For illustration, we adduce two general laws which spring from this theory.

1st. No hypotheses nor arguments can be based on the composition of the gases expired by plants, without a rigorous regard to the influence of disturbing causes—as the amount of light, gas of the fluids of the soil, of the atmosphere, &c.

2d. No experiments on the action of plants in sunlight or otherwise, can be adduced for physiological argumentation, unless made in atmospheric air. Many observations have been made on plants immersed in water and artificial atmospheres, which cannot be received, because the gases employed have penetrated the interior in proportions differing from those in the case of common air. The nitrogen obtained by Saussure may in a great measure have been derived from the additions of carbonic acid made by him to the atmospheres in which he experimented; and in the observations made in water, much of the nitrogen is unquestionably derived from the fluid.

39. Finally I would present the following summary of conclusions as fairly deduced from the preceding experiments.

1. The *epidermis* of plants, so far as experiments have been made, is porous and permits the passage of gases, according to the physical laws of penetration.

2. The *roots*, during the existence of chemical changes in plants, absorb such gases only from the soil fluids with which they are in contact, as will indirectly satisfy the indications of the internal atmosphere.

3. The *internal gas of plants*, or plant atmosphere, is continually fluctuating with the forces which operate upon it; during a state of activity in the plant, it resembles a mixture of nitrogen 86·75, oxygen 13·25 per cent., but at night appears to contain more oxygen, and from 2 to 3 per cent. of carbonic acid.

4. Its active or *normal* composition is that indicated by a mixture into which carbonic acid and oxygen are being diffused during day-light.

5. The *porosity* of the entire plant is fully established by its action on artificial atmospheres.

Therefore the physical structure of plants is that of a porous system, subject to all the laws of diffusion, and endowed with no vitality other than that resulting in the formation and development of Cytoblasts and their arrangement after a definite type.

New York, March, 1846.

Art. VII.—*On Zoophytes;* by J. D. Dana.*

The singular features of the growing coral field, the resemblance to vegetation in its productions, as well as their beauty and variety, have long excited the attention even of those little curious in the forms of living nature. Trees, shrubs, and other plants of various kinds are represented with wonderful exactness, as if they had been the types of this branch of the animal kingdom; and they grow mingled together often in rich profusion like the plants of the land. The similarity, moreover, is not confined to general form: corals have their blossoms; for polyps are flowers both in figure and beauty of coloring. Like the pink or Aster, they have a star-like disk above; and while some are minute, others are half an inch or even two inches in diameter. Every part of a Madrepore when alive is covered with these blossoms: a Gorgonia, though merely a cluster of naked stems, as seen in our cabinets, consists, when in the water, of as many crowded spikelets of flowers.—Thus it is with all zoophytes. Nothing could be more untrue than the night-mare dreams of a favorite poet.†

> "Shapeless they seem'd, but endless shapes assumed;
> Elongated like worms, they writhed and shrunk
> Their tortuous bodies to grotesque dimensions.—"

And again, they are described as issuing from the coral, like

> "capillary swarms
> Of reptiles horrent as Medusa's snakes."

Polyps are not writhing worms. The choicest garden does not produce flowers of more graceful figure or gayer colors, than those of the zoophyte reef; and we may add too, that the birds of the groves will not rival the rich tints of the fishes that sport

* In the series of articles on zoophytes, which it is proposed to prepare for this Journal, the writer presents the facts and principles that have been published in his Report on Zoophytes, one of the volumes of the late Exploring Expedition under Capt. Charles Wilkes, (see this Journal, Second Series, vol. i, p. 178.) The subject is however condensed, and the stile and arrangement altered to adapt it to these pages, and give it a somewhat more popular character. It is the writer's endeavor to present a succinct account of this department, about which there is little generally known, without confining himself to original observations.

† Montgomery's Pelican Island.

among the coral branches. The coral tree is without verdure, but there is full compensation in its perpetual bloom.

It is not surprising that these resemblances should have misled early investigators. For a long period only the external forms of zoophytes were known, and every analogy observed authorized their arrangement with plants.* The discovery of the flowers or seed of corals was yet to be made to prove the identity; and at last, Marsigli, an active explorer of the Mediterranean, came forward with this veritable discovery itself, and published figures of "*les fleurs du corail*"—the coral blossoms.† Other discoveries followed: but it was soon shown, that these flowers, were gifted with the attributes of *animal* life. This observation is said to have been first made by Ferrante Imperato, a naturalist of Naples, who published his *Historia Naturale* in 1599.‡ It was however demonstrated independently, as is believed, and more thoroughly, by Peyssonel, who wrote an elaborate memoir on certain species examined by him in the West Indies.§ But before a transfer of zoophytes from the vegetable to the animal kingdom was generally allowed, the subject was one of warm debate among the philosophers of the day. The animals detected were suspected of being parasites, and pronounced as too inefficient for the production of trees of stone with their spreading branches; while the formation of coral was attributed to a kind of vegetable growth by some, and to mineral aggregation or crystallization by

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* Among the authors who arranged corals with the vegetable kingdom are Dioscorides, Cæsalpin, Bauhin, Ray, Geoffroy, Tournefort, and Marsigli.

† Marsigli, Physique de la Mer, Amsterdam, 1725. His first observations were made in 1706.

‡ See Blainville's Manuel d'Actinologie, p. 14.

§ Peyssonel's Memoir covers 400 pages of manuscript. It was sent to the Royal Society in 1751, and an abstract of it was read, which appeared in the Transactions for 1753, (vol. x, of the Abridgment.) The Memoir, though for many years supposed to be lost, is still extant in the library of the museum at Paris; and a late notice of it by M. Flourens may be found in the Annales des Sciences Naturelles, 2nd ser., ix, 334, 1838.

Dr. J. Parsons made a labored and apparently successful reply to Peyssonel before the Royal Society in 1752, in which he argues *ab ignorantiâ*: "It would seem to me much more difficult to conceive that so fine an arrangement of parts, such masses as these bodies consist of, and such regular ramifications in some, and such well contrived organs to serve for vegetation in others, should be the operations of poor, helpless, jelly-like animals, rather than the work of more sure vegetation, which carries on the growth of the tallest and largest trees with the same natural ease and influence as the minutest plant."

others.* The scientific world was divided, and Reaumur in his earlier writings condemned the new views advocated by Peyssonel as too absurd to be discussed. The investigations of Trembley on the Hydra polyps, and of Jussieu of other species obtained on the sea-coast of France, finally convinced Reaumur. Ellis by a laborious series of investigations, led the way in England; and though his facts were doubted by some, they were soon received with full credit.† The figures of these authors represented actual flowers, as regards form; but these flowers were shown to have a mouth, and to be capable of eating like animals. They were actually fed, and the process of digestion watched through its different stages. Moreover they were shown to be an essential and constituent part of the zoophyte. The petal-like organs which produce the striking similarity to flowers, were observed in some instances to be used as arms in taking their prey and conveying it to the mouth; for which purpose they were conveniently arranged in a circle around the mouth. The coral blossoms were consequently declared to be animal in every essential character. Yet Linnæus, after long hesitation, advanced no farther than to admit for zoophytes an intermediate nature between plants and animals. Thus more than a century elapsed after the discussion commenced, before this one simple fact in science became generally believed, that zoophytes are animals, and resemble plants only in sometimes assuming the shapes of vegetation. The point is now no longer doubted.

In these remarks we exclude sponges from the class of zoophytes. Their nature is still a subject of dispute, and some of the most distinguished names in science are committed on opposite sides. If animals, they have only the most general properties of animal life, and are less nearly related to polyps than to the infusorial animalcules. They are arranged with the latter by Dujardin.

Though zoophytes have no connection with the vegetable kingdom, polyps may be styled with much propriety *flower-*

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* P. Boccone, *Museo di Fisica, &c.*, Venice, 1694, 1 vol. 4to, with figures. Baker, *Employment for the Microscope*, pp. 218—220. London, 1753.

† Ellis published various memoirs in the Philosophical Transactions, from the years 1753 to 1776, and also a work entitled *Essay towards a Natural History of Corallines*, 4to, with plates; London, 1754. A posthumous work of this author was afterwards published by Solander, under the title, *The Natural History of many curious and uncommon Zoophytes*, 4to, with 63 plates, London, 1756.

animals. The word zoophyte,* originally used by Linnæus, alluded to their supposed intermediate nature. Still, the name is sufficiently appropriate, although the idea in which it originated is exploded. They are plants in form even to the coral-polyps which blossom over the surface. Yet in the mode of receiving, digesting, and assimilating nutriment, and every other function of life, they are animal.

The relation of the coral to the coral animal, and the mode of its formation, are subjects about which much error has been published; and although now correctly explained in some scientific treatises, very erroneous impressions largely prevail. Without entering into particulars in this place, one single fact should be here stated and duly considered. It is this:—coral is not the residence or hive of polyps. On the contrary, it is contained *within* the polyps, instead of containing them. It is formed *within* them by animal secretion, as bones are formed within other animals; and in most living zoophytes it is wholly enclosed, showing not a spine or point externally. This is the case with the Madrepore; no part of the coral is seen externally while the animal is alive in the water. The idea that coral polyps retreat into cells, is therefore wholly without foundation. Sometimes the summit or flower-shaped part of the polyp becomes concealed, in a manner a little similar to the withdrawal of a turtle's head; but even this semblance of retreat is by no means general among the ordinary coral zoophytes.

There is no mechanical accumulation of material by the polyp. They are as unconscious of the coral secretions going on within them, and as free from actual labor and industry, as we are in the construction of our bones.

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* The word zoophyte is from the Greek ζωον, *animal*, and φυω, *to grow like a plant.* Blainville states that the term was introduced by Sextus Empiricus and Isodore de Seville in the sixth century. It has been differently restricted in its use by authors, and on account of its various applications, is wholly rejected by Lamarck. Other late scientific writers retain it, and it is also the popular designation.

Ehrenberg has proposed to substitute *Phytozoa*, derived from the same roots. But science requires a name that will apply to the whole compound structure—the coral tree, sea-fan, or mass of whatever shape;—and phytozoum refers only to a *single* polyp, or phytozoa to polyps in general. These cannot supply the place of the very convenient terms zoophyte and zoophytes. Moreover the term phytozoa or phytozoaires (plant-animals) has been applied to the minute monad-like cellules found in the tissues of some plants, and supposed to be animalcules or plant-entozoa.

The existence of such terms in the science as *polypary*, *polypidom*, applied to coral, signifying a *hive* or *house of polyps*, indicates the errors of former days; errors which science should not perpetuate. As a substitute, the old term *Corallum** is convenient and unobjectionable. *Corallium* has been rejected because of its application to a particular genus of corals. In *Corallum*, we have a familiar word; and one which implies no hypothesis or erroneous comparison. The analogy between the work of the polyp, and that of the bee or ant, though often suggested, is wholly without foundation.

The existence of coral secretions, is by no means essential to the existence of polyps. Although a large number of species form coral, there are also many that are wholly fleshy, or secrete only a few scattered granules of lime. The Actiniæ, or sea-anemones, as they are familiarly called, are examples of these fleshy species. In every point of structure, and in every function except that of coral-secreting, they are identical with coral animals. They have also the same resemblance to flowers when expanded, and their rich tints and large size make them the most brilliant flower-animals of any seas.

One of the most singular characters of zoophytes, is their frequent compound nature. The branching Madrepore is an example of this *compound* structure. There are hundreds of polyps united in a single individual. Each little prominence containing a cell pertained to a separate animal; and by counting these prominences over a branch of coral, the number of flower-animals combined in its production may be ascertained. In the same manner, in Astræas, each radiate cell or depression over the surface marks the site of a polyp. The many animals, though distinct in some functions are still mutually dependent in others, as we shall explain in the sequel.

Although these compound forms are most common, yet there are other zoophytes which are always *simple* polyps. The coral

* Coral has been variously designated in both ancient and modern times. The terms Corallium, Corallum and Curalium, were all used by the ancients, and their derivations and use are discussed at length by Theophrastus in his work on plants, Book IV. Κουραλιον is the ancient Greek form, as says Dionysius, "παντη γαρ λιθος εστιν ερυθρου κουραλιοιο." The more recent Greeks, among whom are Dioscorides and Hesychius, wrote the word κοραλλιον. Among the Latins, Ovid wrote, "Sic et *curalium* quo primum contigit auras tempore durescit." Avienus uses Corallum: "Fulvo tamen invenire *Corallo* quærere vivendi commercica." Among the derivations suggested, that of κορη, *damsel*, and 'αλς, *sea*, appears the most probable.

in such cases is a single isolated cup or radiated disk, and the coral animal is a solitary flower. These simple polyp-flowers instead of being microscopic, are often of large size. While many are but one or two lines in diameter, others are one or two feet. The large Fungia with its stellate surface and sprinkling of emerald tentacles around its central mouth, is one of the most beautiful objects of the coral reef.

The foregoing remarks are presented as an introduction to a more particular account of the structure and habits of zoophytes.

ART. VIII.—*Reply to the criticism on Prof. Twining's Demonstration relating to Parallels.**

To the objections to my proof of Euclid's *postulatum* offered by the Editors of the Journal of Science, upon authority which is shown by the appended initials to be highly worthy of credence, I should have sooner replied but for excess of occupation. Even now I feel constrained to such brevity as may involve the hazard of a want of clearness, except for such readers as may care to refer back to the original PROPOSITION.†

The objector first observes "there must be *some* fallacy" in the reasoning, as cases might be pointed out "where false conclusions would result from applying it with proper modifications, though without essential change." In reply it is sufficient to remark, that, as the principle on which the proof depends, is competent, in my own view, to sustain the most rigid scrutiny, I could not but be incredulous as to the possibility of any such case—*even were it shown that my particular application of the principle to the proof in question involves a fallacy.* It is the less necessary to protract discussion, at this point, inasmuch as the objector has preferred the method—the more masterly one if it can prevail—of specifying the particular respects or steps in which the reasoning fails.

He intimates the existence of several—all however "similar" to the one which alone he specifies as the type of all. A particular conclusion on page 95 is pointed out as "inadmissible," on the ground that "it is founded plainly on the assumption, that

* See this Journal, vol. i, Second Series, p. 147. † Ib. pp. 94—96.

in determining the angle BAD to be such as to contain all of a certain class of lines, every other line is excluded from it; in other words, that the line AD, which is the limit of a certain class of lines, must itself be comprehended in that class." Now, as to the assertion in the first member of this sentence, the reader will perceive by referring to p. 95, that what the critic has treated as an *assumption*, is, in fact, explicitly a *condition of the hypothesis.* For not only the application itself, in the argument, evinces what was meant by the concise definition of the angle BAD, as being "constituted by the condition that it can contain all the lines drawn, &c.," but the terms themselves intend that "every other line is excluded," as completely as if that phrase had been adopted in the wording;—how else could the angle be said to be *constituted*, or what is the same, *defined.** If then the line AD is one of the class of which the angle BAD is defined just to contain all and "*no other*," (if that last part of the expression is important to appear in the wording,) it is contained by the angle, in accordance with the *hypothesis*, and on the reverse supposition it is, *by the hypothesis*, excluded.

I perceive, therefore, in the step objected to, no defect even of expression. The discerning reader cannot fail, at least, to take the argument, in its real force and meaning, to be as follows:—If you constitute BAD capable of containing all those lines and those only through A, which, if produced, would meet FG on the side towards G, you cannot constitute DAC similarly conditioned with respect to all those which would *not* meet. The ground of this assertion *lies in the antecedent proof* that under such a supposition, AD must be contained by both BAD and DAC or by neither, and, under the hypothesis, either side of the dilemma involves the absurdity that AD meets and does not meet at the same time. I know not what attempt can be made to escape from the conclusiveness of this reasoning, unless by either denying *the allowable character of the hypothesis itself*, or taking the ground that when a line divides an angle, *the being contained in either part or not contained, cannot be predicated of the line.* The first, or a denial of the hypothesis, is forbidden by the perfection of the idea of *space:* the latter ground, if taken, would

* Thus, to refer, *for exemplification merely*, to an instance in common parlance—if the gallon measure were said to be *constituted* so as to contain 231 cubic inches, the obvious intent would be *just that amount and no more.*

not weaken the argument; for since the angle BAD is expressly conditioned to contain all the lines of a certain class, and only such lines, it follows that if it cannot be predicated of AD that it is contained in the angle it is not one of the class, and *vice versa.*

Turning now to the other part of the objection, in the second member of the sentence above quoted, beginning with the phrase "in other words," I maintain it to embody not other *words* merely, but other *ideas*. Not only the two clauses convey propositions that are not identical, but the latter is not deducible from the former, neither does it seem relevant to an argument which turns not upon ideas of "limits" or limiting lines, under a classification simply *logical*, but upon a certain *natural* or *geometrical* relation of a line dividing an angular space to the component parts of the space it divides.

If, therefore, no more weighty objection than these or the "similar" ones adverted to can be adduced by a critic of such unquestionable discernment as the one whose authorship I perceive in his initials, it may be counted as a new *symptom*, added to those remarked upon in the original paper, of the genuineness of the reasoning; and with respect to the epithet "plausible," applied by the Editors of this Journal—in a manner entirely courteous I acknowledge—to that reasoning, I should not hesitate to transfer it, in a manner not *uncourteous* I trust, to the objections urged against it.

If there is a fallacy in the attempted demonstration, it is to be found, as I judge, after carefully revising the method, in the following conclusion near the bottom of p. 95, "and, of course, HAD must contain all that can meet on neither side." If an objector should urge that, although under the supposition of more lines than one that meet on neither side, HAD might be constituted, independently, to contain them *all* and no others, yet that such a constitution could not co-exist or be compatible with the antecedent constitution or definition of BAD and DAC, I acknowledge that the best answer I could give, at present, does not seem entirely satisfactory.

May 5th, 1846.

Art. IX.—*Abstract of Thermometrical Records kept at the Missionary Stations of the American Board of Commissioners for Foreign Missions in Western Asia;* collected and collated by Rev. Azariah Smith, M. D.

The accompanying abstract of a number of thermometrical records, has been arranged in a tabular form, to present to the reader the relative temperature of the different missionary stations of the American Board in Western Asia. The records from which this abstract was prepared, were kept, for the most part, by persons accustomed to such observations, and may be depended upon for accuracy. The posts of observation have indeed been cities, and where there has been more or less difficulty in securing a place for the thermometer free from the direct or reflected rays of the sun, but it is believed that care has effected all that could be done to avoid error from these circumstances. With the exception of three or four months in the Oormia register, the records exhibit the omission of observations for scarcely a single day other than those noted in the table, and even in the Oormia record, the omissions are not such, it is hoped, as materially to detract from its value as affording a general indication of the temperature of that place. Several of the records from which this abstract was made, contain full statements of the aspect of the sky, morning, noon, and night; several also note the direction of the wind at these times; and a few have complete and well kept barometrical observations. As the barometrical registers however have been already published, and as it is impossible to collate the observations on the sky and the currents of the air into a compact form, I have reluctantly substituted for these a few brief general remarks, and in the abstract, confined myself, to the thermometrical records.

As it may add to the value of the observations for 1844, I would mention in conclusion, that the registers for that year were kept according to previous arrangement, *simultaneously*, and with the express design to furnish a comparative view of the temperature of the places in which the records were made. It is to be hoped that the publication of this abstract may call out similar ones from American missionaries stationed in other parts of the world.

Place of record.	Year of the record.	Average temp. sunrise.	Average temp. 2 P. M.	Average temp. 9 P. M.	General av. for month.	Coldest temp. and its date.	Warmest temp. and its date.
JANUARY.							
Oormia,	1845	°11·	°22·	°14·	°15·67	°3	°36
Erzeroom,	1836	*16·27	†16·37			–10	38
	1837	*16·8	†22·39			–4	40
	1838	‡17·81	19·51	‖8·54	15·29	–20	34
Trebizond,	1839	*41·16	†47·39			39	64
	1844	44·52	48·35	45·68	46·18	28th, 31	12th, 62
	1845	*39·64				12th, 31	28th, 53
Constantinople, (Bebek,)	1844	38·70	42·13	39·40	40·07	20th, 24	29th, 53½
	1845	40·1	47·73	42·19	43·34	20th, 30	23d, 58
Constantinople, (Pera,)	1840	§37·35	41·35	**39·35	39·68	18	54
	1841	§42·71	45·48	**43·35	43·85	29	56
Broosa,	1844	35·	41·5	38·	38·17	27th, 24	9th, 58
	1845	36·32	46·81	39·1	40·74	16th, 25	31st, 60
Smyrna,	1844	39·	49·	42·66	43·55	27th, 27	23d, 57
Beirût,	1843	54·	59·25	††57·36	56·88	51	67
	1844	50·	59·14	52·04	53·76	23d, 44	18th, 71
	1845	46·74	57·90	49·19	51·28	36	64
Aitath,	1843	46·	53·30	††50·	49·75	42	59
Jerusalem,	1844	44·63	51·09	47·45	47·72	40	61
Mosul,	1844	38·	47·	††46·	43·67	1st, 30	14th, 55
FEBRUARY.							
Oormia,	1845	25·	40·	28·	31·	8	56
Erzeroom,	1836	*25·93	†27·67			10	41
	1837	*19·08	†21·81			0	38
	1838	‡23·37	25·06	‖14·18	20·87	–10½	42½
Trebizond,	1839	*46·56	†46·92				
	1844	50·1	52·85	51·96	51·04	20th, 38	23d, 67
	1845	*46·46				33	4th, 66
Constantinople, (Bebek,)	1844	47·0	48·9	49·3	48·4	2d, 36	29th, 69
	1845	40·14	45·33	40·57	42·01	18	3d, 62
Constantinople, (Pera,)	1840	§37·59	41·04	**38·07	38·90	25	59
	1841	§37·25	42·82	**38·57	39·58	31	56
Broosa,	1844	47·5	55·5	50·0	51·0	26th, 36	29th, 72
	1845	40·38	47·36	41·18	42·97	22d, 23·5	2d, 65
Smyrna,	1844	47·02	59·48	50·39	52·3	18th, 32	29th, 68
Beirût,	1843	56·71	63·85	††61·89	60·82	53	69
	1844	52·80	62·33	55·25	56·79	48	70
	1845	52·82	64·03	54·10	56·98	47	72
Jerusalem,	1844	50·02	58·09	53·07	53·73	45	66
Mosul,	1844	44·	††55·	51·	50·	1st, 35	26th, 63
MARCH.							
Oormia,	1845	26·	37·	30·	31·	11th, 22	24th, 70
Erzeroom,	1836	*30·75	†35·87			1	49·5
	1837	*37·41	†34·11			14	52
	1838	‡34·06	35·87	‖24·05	31·33	15	48
Trebizond,	1839	*43·41	†43·45			39	51
	1844	50·26	52·84	50·52	51·21	17th, 40	10th, 71
Constantinople, (Bebek,)	1844	46·29	51·16	44·9	47·45	31st, 38	8th, 67
	1845	47·13	55·26	49·19	50·53	3d, 34	19th, 78
do. (Pera,)	1840	§37·84	42·52	‖39·06	39·81	24	57
	1841	§39·19	43·29	‖40·06	40·84	29	53
Broosa,	1844	45·	53·	47·5	48·5	25th, 36	9th, 76
	1845	50·13	59·65	52·55	54·11	25th, 35	20th, 86
Smyrna,	1844	47·93	60·93	50·21	53·02	15th, 39	9th, 75
Beirût,	1843	57·16	65·32	††58·88	60·32	50	73
	1845	57·87	69·	59·70	62·19	49	84
Aitath,	1843	50·23	58·14	††52·50	53·62	40	76
Jerusalem,	1844	53·	69·	58·03	60·01	47	74
Mosul,	1844	51·	62·	††58·	57·	17th, 45	21st, 69

Index to signs: * 9 A. M. † 4 P. M. ‡ 8 A. M. ‖ 8 P. M. § 7 A. M. ** 10 P. M. †† Sunset.

Place of record.	Year of the record.	Average temp. sunrise.	Average temp. 2 P. M.	Average temp. 9 P. M.	General av. for month.	Coldest temp. and its date.	Warmest temp. and its date.
APRIL.		°	°	°	°	°	°
Erzeroom, . . .	1836	*46·5	†50·15			34	62
	1837	*46·83	†51·13			41	62
	1838	‡47·23	48·02	‖36·63	43·96	30	64·5
Trebizond, . . .	1838	*51·13	†51·76			39	73
	1839	*47·73	†47·9			44	54
	1844	45·79	48·68	46·66	47·04	13th, 33	29th, 66
Constantinople, (Bebek,)	1844	45·7	52·29	45·27	47·75	13th, 36	27th, 74
	1845	52·63	64·43	55·53	57·53	3d, 34	20th, 80
do. (Pera,)	1840	§43·03	50·37	**44·07	45·82	35	61
	1841	§48·23	55·3	**49·97	51·17	40	64
Broosa, ...	1844	44·	53·	48·	48·33	12th, 34	28th, 76
	1845	53·04	69·03	58·33	60·25	3d, 34	12th, 85
Smyrna, ...	1844	44·43	62·33	52·10	52·95	4th, 35	28th, 80
Beirût, ...	1842				67·80	63	92
	1843	61·13	67·23	††64·13	64·16	55	74
	1845	59·07	71·15	62·	64·07	46	85·5
Aitath, ...	1843	52·97	63·17	††57·27	57·80	42	76
Jerusalem, . . .	1844	49·04	64·	51·07	54·70	38	72
Mosul, ...	1844	50·	62·	††57·	56·33	14th, 38	30th, 75
MAY.							
Erzeroom, . . .	1836	*52·22	†55·31			34	72
	1837	*40·	†60·			36	66
	1838	‡54·30	58·57	‖46·5	53·12	41·5	67·5
Trebizond, . . .	1838	*63·23	†63·55			58	70
	1839	*60·12	†60·46			51	70
	1844	57·42	61·61	58·48	59·17	1st, 50	20th, 70
Constantinople, (Bebek,)	1844	55·3	62·22	55·18	57·53	3d, 49	17th, 81
	1845	60·26	72·84	64·35	65·82	6th, 49	31st, 87
do. (Pera,)	1840	§58·03	67·48	**60·32	61·94	47	81
	1841	§56·13	65·36	**58·	59·83	48	75
Broosa, ...	1844	57·	67·	60·5	61·5	5th, 50	22d, 77
	1845	62·81	79·35	68·23	70·13	1st, 51	31st, 93
Smyrna, ...	1844	58·35	74·13	64·23	65·57	4th, 48	21st, 84
Beirût, ...	1842				73·83	62	92
	1843	66·13	72·68	††69·10	69·30	56	83
	1845	68·26	76·39	67·64	70·76	57	97
Aitath, ...	1843	59·45	71·13	††64·10	64·89	48	82
Jerusalem, . . .	1843	§61·21	73·14	69·32	67·89	49	90
	1844	64·	69·	64·06	65·69	55	83
Mosul, ...	1844	66·	82·	74·	74·	1st, 58	24th, 91
JUNE.							
Erzeroom, . . .	1836	*65·83	†65·96			43	80
	1837	*65·66				58	71
	1845	51·	67·9	59·2	59·37	36	79
Trebizond, . . .	1838	*71·73	†70·2			66	80
(16th to 30th,)	1843	69·	76·	70·		62	79
	1844	64·77	70·37	67·	67·38	10th, 57	29th, 78
Constantinople, (Bebek,)	1844	62·23	78·43	64·43	70·32	7th, 56	29th, 94
	1845	65·07	77·6	67·2	69·96	56	86
do. (Pera,)	1840	§62·7	71·03	*64·73	66·15	52	76
	1841	§67·27	74·57	*69·03	70·29	59	80
Broosa, ...	1844	64·	80.	70·5	68·17	7th, 54	29th, 96
Smyrna, ...	1844	65·9	82·33	72·14	73·46	22d, 60	30th, 92
Beirût, ...	1842				75·43	69	84
	1843	72·77	77·97	75·43	75·39	69	82
Aitath, ...	1843	64·60	75·27	69·23	69·70	59	84
Jerusalem, . . .	1843	§65·30	77·56	72·16	71·74	60	88
Mosul, ...	1843	80·1	92·31	††90·14	87·52	76	100
	1844	76·	96·	88·	86·67	3d, 65	19th, 104

Index to signs: * 9 A. M. † 4 P. M. ‡ 8 A. M. ‖ 8 P. M. § 7 A. M. ** 10 P. M. †† Sunset.

Place of record.	Year of the record.	Average temp. sunrise.	Average temp. 2 P. M.	Average temp. 9 P. M.	General av. for month.	Coldest temp. and its date.	Warmest temp. and its date.
JULY.							
Oormia, 15th to 31st,	1844	66·59°	86·15°	74·°	75·58°	15th, 64°	25th, 88°
Erzeroom,	1836	*69·56	†75·11			56	88
	1837	*69·04				56	77
	1845	58·5	76·5	66·5	67·17	46	80
Trebizond,	1838	*74·77	†75·03			70	84
	1843	70·	78·	72·	73·33	60	87
	1844	72·8	79·57	75·7	76·02	9th, 68	21st, 86
Constan. (Bebek) 19 to 31,	1844	71·92	82·04	75·15	76·37	25th, 60	20th, 86
Constantinople, (Pera,)	1840	§73·03	81·23	*74·1	76·12	66	88
Broosa,	1844	71·5	87·5	78·5	79·17	24th, 63	4th, 98
Beirût,	1842				82·38	76	95
	1843	78·15	84·74	81·67	81·52	74	88
Aitath,	1843	71·16	78·71	75·26	75·04	64	87
Bhamdun, 20th to 31st,	1843				73·50	68	78
Jerusalem,	1843	§72·35	84·44	75·23	77·34	66	94
Mosul,	1843	82·1	100·97	††94·48	92·52	74	106
	1844	86·	10·6	95·	95·67	10th, 78	24th, 114
AUGUST.							
Oormia,	1844	68·	83·	73·	74·67	10th, 57	1st, 89
Erzeroom,	*1836	*69·12	†80·5			62	86
	1837	*65 37				56	75
	1845	59·5	79·5	67·5	68·83	52	84
Trebizond,	1838	*75·19	†75·32			70	81
	1843	71·	80·	68·	73·	45	85
	1844	70·93	77·91	74·4	77·47	26th, 67	1st, 84
Constan. (Bebek,) 1 to 8,	1844	70·71	83·	75·14	76·28	68	1st, 85
Constantinople, (Pera,)	1840	§69·35	77·87	*71·52	72·91	65	84
Broosa,	1844	67·	84·0	74·5	75·17	19th, 61	1st, 92
Beirût,	1842				83·00	78	89
	1843	77·07	84·61	81·76	81·13	75	87
Aitath,	1843	64·11	77·05	72.63	71·26	66	82
Abeih,	1843	65·03	72·94	67·26	68·41	59	80
El Abadiyeh,	1843	65·64	75·54	72·68	72·29	62	81
Bhamdun,	1843				69·16	62	84
Jerusalem,	1843	§68·25	79·06	70·33	72·55	66	90
Mosul,	1843	81·03	98·	††92·9	90·64	74	105
SEPTEMBER.							
Oormia,	1844	57·	78·	64·	46·33	24th, 50	5th, 85
Erzeroom,	1836	*55·37	†64·19			38	76
	1837	*60·65				44	69
Trebizond,	1838	*73·17	†72·93			68	78
	1843	65·	73·	66·	68·	59	79
	1844	68·13	73·83	69·56	70·51	23d, 63	2d, 81
Constantinople, (Bebek,)	1844	65·28	76·31	68·31	69·93	29th, 60	2d, 83
do. (Pera,)	1840	§65·43	72·87	**67·3	68·53	60	84
Broosa,	1844	63·	79.	68·5	70·17	28th, 58	14th, 89
Smyrna,	1843	60·2	76·51	68·1	68·27	51	85
Beirût,	1842				82·67	78	93
	1843	72·77	82·13	††74·83	76·58	70	86
Aitath,	1843	64·87	72·93	††69·10	68·97	59	80
Abeih,	1843	59·52	68·69	††64·15	64·12	54	80
El Abadiyeh,	1843	62·47	72·13	††68·67	67·76	58	85
Bhamdun,	1843				71·83	62	83
Jerusalem,	1843	70·28	77·18	69·27	72·24	62	89
Mosul,	1843	71·71	87·69	††83·55	80·98	30th, 68	18th, 93

Index to signs: * 9 A. M. † 4 A. M. ‡ 4 P. M. ‖ 8 P. M. § 7 A. M. ** 10 P. M. †† Sunset.

Place of record.	Year of the record.	Average temp. sunrise.	Average temp. 2 P. M.	Average temp. 9 P. M.	General av. for month.	Coldest temp. and its date.	Warmest temp. and its date.
OCTOBER,							
Oormia, ...	1844	48°·	65°·	55°·	56°·	21st, 40°	12th, 72°
Erzeroom, ...	1835	*51·69	†57·48			43	65
	1836	*48·19	†58·			35	66·5
	1837	‡45·52	48·87	*40·96	45·12	26	62
Trebizond, ...	1838	*60·95	†62·15			49	81
	1843	63·74	69·86	65·42	66·34	54	86
1st to 18th,	1844	60·56	67·75	63·11	63·81	13th, 53	9th, 76
Constantinople, (Bebek,)	1844	59·53	69·56	60·	63·03	2d, 50	17th, 76
do. (Pera,)	1840	§57·58	63·94	**59·29	60·27	45	77
Broosa, ...	1843	57·31	69·35	59·83	62·15	51	79
	1844	57·5	69·	61·5	62·67	20th, 50	22d, 77
Smyrna, ...	1843	55·32	70·73	62·15	62·73	46	79
Beirût, ...	1842				79·82	72	90
Bhamdun, 1st to 15th,	1843				67·33	53	82
Jerusalem, ...	1843	§64·08	74.04	67·13	68·42	60	89
Mosul, ...	1843	65·3	78·65	††74·71	72·89	56	87
NOVEMBER,							
Oormia, ...	1844	36·	56·	42·	44·67	21st, 23	7th, 68
Erzeroom, ...	1835	*35·43	†41·07			6	50½
	1836	*33·52	†40·78			13	54
	1837	‡35·32	40·17	‖33·13	36·21	24	53
Trebizond, ...	1838	*58·85	†59·38			45	48
	1843	57·	61·	58·17	58·72	46	69
Constantinople, (Bebek,)	1844	55·21	61·72	56·03	57·65	29th, 39	10th, 76
do. (Pera,)	1840	§52·53	57·3	**54·13	54·65	31	66
Broosa, ...	1844	53·	62·5	57·	57·5	29th, 34	10th, 82
Smyrna, ...	1843	49·90	60·34	53·67	54·64	40	70
Beirût, ...	1842				68·56	58	81
	1843	61·10	67·41	62·21	63·57	52	78
	1844	59·77	71·70	63·47	64·98	47	81
Jerusalem, ...	1843	56·08	62·08	58·63	58·93	48	78
Mosul, ...	1843	56·43	62·5	59·4	59·44	48	79
DECEMBER.							
Oormia, ...	1844	28·	31·	29·	29·33	28th, 12	8th, 46
Erzeroom, ...	1835	*22·07	†24·09			0	44
	1836	*19·	†24·05				
	1837	‡22·97	26·04	‖17·55	22·22	−7	39
Trebizond, ...	1838	*45·77	†46·67			34	57
	1843	44·65	49·29	45·67	46·54	36	62
	1844	*42·03				31st, 30	21st, 54
Constantinople, (Bebek,)	1844	39·68	44·2	40·19	41·36	5th, 26	15th, 53
do. (Pera,)	1839	§43·41	46·1	**43·97	44·49	18	54
	1840	§37·06	40·48	**38·26	38·6	23	55
Broosa, ...	1844	37·5	44·	39·	40·17	6th, 24	13th, 55
Smyrna, ...	1843	39·03	50·93	41·39	43·78	26	62
Beirût, ...	1842				60·13	52	70
	1843	51·26	58·63	††52·52	53·93	42	66
	1844	52·71	60·87	54·42	56·	46	70
Aitath, ...	1842				51·87	42	66
Jerusalem, ...	1843	§45·	50·08	47·06	47·38	36	58
Mosul, ...	1843	42·45	49·36	47·	46·27	30	57

Index to signs: * 9 A. M. † 4 P. M. ‡ 8 A. M. ‖ 8 P. M. § 7 A. M. ** 10 P. M. †† Sunset.

Abstract of the foregoing, showing the annual average and range of temperature in the specific years—arranged in the order of the average temperatures.

Place.	Altitude.	N. Lat.	E. Lon.	Year, A. D.	Av. for year.	Coldest.	Warmest.	Range.
Erzeroom, .	6225	39° 57′	40° 57′	1838	43°·61	−20°	84°	104°
Oormia, . .	5000 ?	37 30	45 10	'44 & '45	50· ?	3	89	86
Bebek, . .	150	41 7	28 59	1844	58·01	24	86	62
Broosa, . .		40 5	29 10	1844	58·22	24	98	74
Trebizond, .	100	41 1	39 45	'43 & '44	59·51	31	86	55
Smyrna, .	50	38 26	27 7	'43 & '44	61· ?	26	85	59
Jerusalem, .	2500	31 47	35 14	'43 & '44	62·80	36	94	58
Mosul, . .		36 19	43 10	'43 & '44	67·80	30	114	84
Beirût, . .	50	33 50	35 28	1843	68·32	44	90	46

The former of the above tables, it is thought, sufficiently explains itself. The comparison instituted between the temperatures of the several places mentioned in the latter, should be considered only as an approximation to accuracy, since, as will be seen by reference to the first table, some of the records from which it was prepared were incomplete; and those not so, want for perfect uniformity as to the hours of the day, and even as to the year, when the observations were made. Still, with these, and any other imperfections which the strictest scrutiny may detect in the materials collated, it is believed that the table yet gives, what is designed, a correct general idea of the relative temperature of the several posts of observation.

In regard to the meteorology of Western Asia, one or two prominent peculiarities are worthy of special notice. During a period of several weeks in the warm season, rain is rarely or never known to fall. In Syria this period embraces the months of June, July, August, and September, with but little rain in May and October. At Mosul the dry season commences a month earlier than this, and at Erzeroom a month later, but in its termination there is not observable the same disregard to simultaneousness. The other places from which we have records, (Oormia excepted,) although exposed to a long dry season during the summer, are scarcely ever, owing to their relations to large bodies of water, entirely destitute of showers for a whole month at a time. The summer of 1845 has been remarkable for excessive drought in Asia Minor and the neighboring part of Turkey in Europe; so excessive, indeed, as to prove fatal to a large proportion of all the crops on the ground, and to lead the Sultan to prohibit exportations of grain from the affected region, lest the consequence should be extensive famine and suffering during the ensuing winter.

All of the places recorded in the table, are subject more or less, at all seasons of the year, to siroccos or hot and dry winds, which bring with them, as is supposed, the climate and temperature found over the interior and extensively desert country. These winds sometimes prevail for several days together, in which case they never fail to produce an excessive languor and lassitude. At Mosul, the air at such times is filled with particles of sand, and however close one may shut up his apartment, he will be notified of the existence of the wind, by the oppression of his breathing, and by the deposit of this fine sand around him, and in every crack and crevice to which the air can find access. May it not be that the effect produced upon animal life by this wind, is in all cases to be attributed as much to inpalpable substances which it brings into the lungs, as to its heat and the quantity of moisture which it abstracts from the body. The peculiar color of the air during some siroccos can hardly be accounted for on any other supposition. By carefully comparing the registers from which the abstracts were prepared, it is found that these winds visit at the same time, all those parts of Asia Minor which are reported. As the highest temperature of each month generally takes place during the sirocco, if one occurs, it has been attempted to present some evidence of this simultaneousness by noting in the first table the *date* of the highest temperature of several months of 1844 and '45. March, April, May, June, July, and August, 1844, and February and March, 1845, may be referred to as well marked cases of this kind. Those instances however which appear exceptions in the table, are not in fact exceptions to our remark, since during the sirocco the highest heat of the month may not occur: e. g. Feb. 29th, 1844, gives us 62° as the temperature of Trebizond, and July 21st of the same year, though not the warmest day of that month in Broosa, was yet nearly so, the temperature being 92°. In the northern part of Asia Minor the sirocco ordinarily blows from the south; in Cyprus, I am told, it as regularly blows from the north; but in Syria, as the records show, no such uniformity of direction seems to exist. It may come from N. E., E., or S.

With respect to the peculiarities of climate at the several places in which the records collated in the tables were kept, the remarks which follow are designed to be brief, and to touch only upon the most important features of each, as they would strike an observer moving consecutively from one place to the other.

At Erzeroom, we find, as might be expected from a place in the latitude of 40°, and more than a mile above the level of the sea, a cold winter and relatively cool nights throughout the whole year. The heat of summer, more particularly of the middle of the day, is however less modified by the circumstances of latitude and elevation than one would suppose from the mention of these particulars alone. The extensive and nearly barren plain, which stretches for several miles north and west of the city, has undoubtedly much to do in counteracting the causes of cold which exist there, as in places similarly elevated. A remarkable freedom from wind, which occurs during the winter season, serves greatly to diminish the amount of sensible cold, and a person may sometimes be in the open air when the mercury is very low, without being at all sensible of the extreme cold indicated by the thermometer. As it is natural to associate clouds and storms with mountainous regions, the dry season of Erzeroom, though not so long as that of Syria and the region of Mosul, is a feature of its climate well worthy of mention. None of the gardens and fields around the city, nor indeed any where upon the plain, are expected to bring their productions to maturity without being watered by artificial means. This remark is supposed to be true very generally of all Turkey in Asia not lying on the declivity which looks toward the Black sea. It is true emphatically of the mountainous region south of Erzeroom, as the writer had occasion to observe when in the country of the Mountain Nestorians in 1844. There none of the lands are considered tillable, except those lying on the borders of streams or where the waters of a spring may be made to flow over them. The dryness of the soil arises not only from the infrequency of rains, but also from the great want of moisture in the atmosphere, there being no large evaporating surfaces like those of our large rivers and inland lakes. In consequence of this, the air needs only to be slightly elevated in temperature, and it becomes greatly undercharged with water. The nearness of the Black sea does little to supply this want, since it is skirted along the whole southern shore with mountains so high as to prevent, to a great degree, the passage over them of the moisture raised from its surface. In travelling over, and along the sides of these mountains, I have been struck day after day and week after week with the difference observable in the meteorology of their two sides. Towards the north, fogs and clouds, and towards the south, a clear and blue sky, were the almost universal order of the day. Early in the morning indeed, the view from the mountains towards the northern horizon is sometimes singularly clear; but low beneath the feet of the observer, a vast sea of clouds stretches before him, and he rarely gets a glimpse, of what he so much wishes, the distant Euxine as first seen by the "Ten Thousand" in their signal retreat. In a short time after the sun rises, the clouds begin to creep up the declivity facing the north, and soon afterwards, attaining the summit, they pour over it towards the south, presenting a white sheet along the mountain ridge not unlike that of the brow of our own Niagara. The destination of the vapory cataract of these high regions is however very different from the one of water which it so naturally suggests. Hardly do the clouds pass these mountain summits before they begin to melt away and disappear in the arid atmosphere, which waits to receive them. Rarely, very rarely, during the summer months, does a north wind prevail so strong as to carry the clouds unbroken over an extended space so far in the interior as Erzeroom. It is only when the season advances, as in October or November, and when the temperature is such as to give the atmosphere a greatly decreased capacity for moisture, that the cloudy, damp, and stormy weather of other mountain regions begins to prevail and the rainy season sets in.*

Trebizond is remarkable for the equable nature of its climate as to temperature, and for the predominance of moisture in its atmosphere, compared with other places mentioned in the above tables. By the abstract in the last of these, it will be seen to present a less range between the extremes of a year, than any other place besides Beirût. If however the average daily range had been taken as a standard of comparison, the result would

* Exceptions of course occur in every climate, and one that took place in that of the plain of Erzeroom during the last season is worthy of mention. On the nights of June 21st and 22d, the writer travelling with a company in tents, encountered a snow storm, (about eight miles west of the city,) which left the ground over the entire plain and the surrounding mountains, covered with snow six or eight inches deep. It was said that few persons living had ever witnessed any thing of the kind, and the Mussulmen made it the occasion for offering special prayer in the mosques.

have been much more striking in favor of the equable temperature of Trebizond, the average daily variation for the year, as thus obtained being 5°, while that of Beirût the one which approximates most, is about 65°. The great moisture of the atmosphere is observed in the tendency of every thing to rust, mould, or acquire dampness, even in the most favorable situation, where not exposed to the direct rays of the sun. The amount of rain which falls at Trebizond, and the great proportion of cloudy weather are also striking features compared with other parts of Turkey, and the remarks made in the preceding paragraph will furnish obvious reasons for these peculiarities. Its situation on the shore of the Black sea, hemmed in behind by mountains, and having a prevalent wind from the water, either in the form of a sea breeze or otherwise, are the causes referred to. Only eighty-three out of two hundred and sixty-eight records made in June, July, August, and September, 1843, and only one hundred and seventy-two out of three hundred and thirty insertions in the register for the same months of 1844, were *clear*, and these months, it is to be remembered, include that part of the year when a clear sky and dry atmosphere most prevail at all the other of our posts of observation. It has been remarked by one of the observers at Trebizond that the ordinary rules for predicting changes of weather from the state of the barometer, do not seem to hold true at Trebizond, but we unfortunately have no such records as will enable us to present the facts now alluded to. Doubtless the vicinity of mountains and the peculiarity of the winds must be the ground of the exceptions referred to; as they are found likewise to effect equally strange and sudden changes in temperature: e. g. March 10th, 1844, we have the thermometer 71° at sunrise and 58° at 2 P. M.; and Feb. 16th of the same year, 48° at sunrise, 37° at 2 P. M., and 45° at 9 P. M. It may be well also to remark that Trebizond is less affected by the sirocco than any other of the places where meteorological tables have been kept.

Constantinople.—The climate of the capital of Turkey furnishes little that is sufficiently striking to merit notice in this brief account. Its situation on the Bosphorus, and between the Black sea and sea of Marmora renders it peculiarly exposed to northerly and southerly winds. On looking over the daily observations of a year, I find the northeasterly winds most prevalent, and that during the whole time there were but two instances of the winds blowing directly across the straits for the entire day, in one of which it was from the east, and in the other from the west. The mildness of its temperature during the winter, is greater than that of the same latitude in the United States, and it is very rare to have any considerable fall of snow; but at the same time there are enough cold rainy days to make the weather on the whole seem more chilly than the bracing air of New England. During the summer there is less of rain and a greater proportion of warm pleasant weather than is enjoyed by the Middle and New England states, but ordinarily there is enough rain to bring grain to maturity without artificial irrigation. There is a common saying here, that one must keep his best fuel until March, and it is observed by foreign residents, that although spring seems pretty uniformly to open in February or the first of March, with fine weather, there are after this, several days if not weeks of the most uncomfortable chilly weather of the whole year.

Broosa.—The inland situation of Broosa, and its location at the foot of Mount Olympus,—which is 7000 feet high and preserves snow on its top throughout the entire year,—causes a greater annual range than exists at any of the sea-ports from which we have records, though not so great as that of Erzeroom, Mosul and Oormia. The effect of the sirocco is more trying and oppressive than at either of the places already mentioned, and I should think from my limited observations, that this wind there, is for some reason, peculiarly frequent. Witness the highest temperature as recorded in the first table for March, April, and May, 1845, and for June, July, August, September, and November, 1844. Still Broosa is considered a very favorable climate for invalids, and crowds of people flock there during the summer to recruit their health at the *natural* hot baths with which the vicinity of the place abounds.

Smyrna.—The annual range of temperature at Smyrna is not very great, but the average daily range, 14°, is wider than that of any of the other places from which we have observations. Its winter consists in a damp, rainy season, and is rarely marked with slight falls of snow; but Americans who arrive here from Boston during this portion of the year, uniformly feel more inconvenience from cold than during previous winters at home, but whether this may not be mainly owing to the change experienced on leaving the sea, is a reasonable question, to settle which, facts are needed that we do not yet possess. The summer of Smyrna is warm compared with that of any of the aforementioned places, and on this account, it is the more to be regretted that our records from this place are deficient for the months of July and August.

Beirût.—The warm climate of this place is what might be expected from its latitude; and the slight annual range of temperature, from its fine exposure to the open sea, from which the wind prevails at all seasons of the year. The force and constancy of the southwest wind is such as to be constantly making its impress upon the land; the sand rolled up by the sea, is raised into the air and driven in such vast quantities into the interior, southeast of the city, as to form there, high ridges, which by gradual advances of a few feet each year, are covering up trees, gardens, vineyards, and even houses themselves when they are not removed in anticipation of the calamity.

Mosul.—No one can cast an eye at the records of this place, without being struck with the extreme heat of the weather during the summer months. So excessive indeed is the temperature that it will not be strange if some of the readers of this article are incredulous with regard to the accuracy of the observations, from which the above abstract was made. But the writer may state, that before the place of observation was fixed upon for the summer of 1844, three thermometers were suspended several days in succession, in the most eligible situations in the house in which he then resided, (a house favorably situated too, it being on the highest ground in the city,) and that among these a place was chosen, which, while it was not affected by the confined air of the court, was also in no way exposed to the direct rays of the sun, and as little as possible to the reflected rays. Moreover, the opportunity was afforded of occasionally comparing the temperature thus given, with that of a thermometer suspended in a good position, at the country residence of the French Consul, among the ruins of ancient Nineveh (?), and there is therefore every reason to believe, that local causes had very little effect on the mercury of the thermometer with which the record was made. The temperature at 9 o'clock P. M., strongly corroborates this, as does also the fact that the removal of the thermometer into the sun at noon, would always cause the mercury to rise at once to 144° or 146°. On account of this excessive heat, all who are able, have rooms fitted up in their cellars, where they retreat to spend the middle of the day. The nights are uniformly spent on the flat roofs, dew and rain being wholly unknown during the summer season. One peculiarity growing out of this extreme heat of the climate, was often the subject of our remarks. Contact with every thing dry communicated the sensation of heat, our beds seemed to have been just scorched with a warming-pan, and stone floors appeared as if endowed with the power of generating caloric. Instead of being refreshed by the cooling sensation which a change of clothes ordinarily gives in the summer, the linen taken out of our coolest wardrobes seemed always, on putting it on, to have come roasting hot from the mouth of some glowing furnace.

Respecting Jerusalem and Oormia, not having visited those places, we are unable to give, according to the plan pursued with regard to the other points from which we have records, any prominent meteorological peculiarities which might not be inferred from the above tables. A great tendency to intermittent fever is known to exist on the plains of Oormia, and may be mentioned as one peculiarity of the climate of that place as a mission station. The cause of this is no doubt to be found, either in the miasmata of the city or the exhalations from the great lake which bounds those plains on the east.

From observations made for several years by the missionaries resident in Beirût, Trebizond and Oormia, it has been found that by leaving those cities for the mountains near at hand, during the summer months, they obtain a healthier and far more pleasant place of residence. This has led to a careful comparison between the temperature of the plain and the places of resort on the mountains, and in neither of these cases does the average variation exceed 7° or 8° Fahrenheit. Still, the variation in one's feelings is very manifest, even in ascending four or five hundred feet. While, on the plain the parched and sultry air of a summer's day seems almost insupportable, the breeze of the upper strata of air seems to refresh and revive the spirits, and to infuse new life into the whole system. "What is the cause of this effect on the physical frame?" is yet a question open for investigation. Would the residents at Oormia be refreshed by a sudden removal to the sides of Mt. Lebanon, or to the hills back of Trebizond? If so, as such a removal would bring them two or three thousand feet nearer the level of the sea, it is plain that the effect is not produced, as is commonly supposed, by the diminished pressure of the atmosphere in elevated regions. Without doubt, differences in the electrical state of the air, will yet be found a fertile cause of various modifications in the working of the nervous system, but as we have thus far been unable to obtain any facts of this kind in respect to the cases now referred to, we must leave the question they suggest where we found it.

It remains only to mention the individuals whose kindness and interest in meteorology has enabled us to present to the public the above tables. James Brant, Esq., English Consul at Erzeroom, furnished the records for that place for 1835, 6, 7, and 8, and for Trebizond for 1838 and 9; Rev. Messrs. E. E. Bliss and N. Benjamin, those for Trebizond for 1844 and 5; Rev. P. O. Powers those for Broosa for 1844 and 5; Rev. C. Hamlin those for Bebek; Rev. H. G. O. Dwight those for Pera; Rev. S. H. Calhoun those for Smyrna; Rev. J. F. Lanneau those for Jerusalem; Dr. H. A. DeForest those for the other places in Syria; Rev. Thos. Laurie those for Mosul prior to April 4844; and Mrs. A. H. Wright and Miss F. Fiske those for Oormia.

Art. X.—*Facts relating to the Great Lakes;** by Prof. C. Dewey.

1. *Phenomenon on Lake Ontario.*

On September 20th, 1845, was witnessed a singular phenomenon on Lake Ontario. In the afternoon *the waters suddenly moved, in a mass, out of the rivers, bays, coves, harbors, &c.*, lowering the water to different depths in different places. In ten or twelve minutes the waters returned, and rose to a higher level than they had before. This oscillation or efflux and reflux of the waters was repeated several times at about the same interval of eight to twelve minutes. At the mouth of the Genesee river, seven miles from this city, the water fell two feet below its common level, and soon rose as much above it. The Revenue Cutter, John Y. Mason, lay in the harbor, and the hands witnessed the fall and rise of the waters. At several places along the neighboring shores, boats were left for a few moments on the sands. At Oswego, seventy miles east of this, a large body of logs mov-

* Originally printed in the Report of the Regents of the University of New York, for 1846, p. 228, nearly as prepared for this Journal by the author.

ed out into the lake, to the great annoyance of the owner, till he saw them soon returning to their previous location. At Cobourg, a *little west of the Genesee*, and on the Canada side of the lake, and *distant about sixty miles*, the same fall and rise were observed to be repeated, the greatest being a little before sunset, when the waters rose to their highest point or about two feet. In the efflux the shores had in many places been left dry for some minutes. At Port Hope, a few miles west of Cobourg, the steam-boat Princess Royal, ran aground as she attempted to enter the harbor, so much had the waters lowered in the port.

The cause of this phenomenon is doubtless to be found in the tornado which passed that afternoon over the lake, beginning at Johnston's Creek in Niagara Co., and passing in a northeast course over Orleans Co., till it struck the lake at Oak Orchard Creek, fifty miles west of Rochester, and continued its course across the lake. The tornado was about three fourths of a mile wide in Orleans Co., and was very destructive, twisting off, and bearing away large trees, unroofing and destroying buildings, &c. Its violence was of only few minutes duration, perhaps not over three. On the lake, it produced water spouts and was attended with large hail, and lightning and thunder. The steam-boat Express, Capt. Mason, was in great jeopardy from the wind and waves and storm, as she was then passing up the lake on her regular trip. The power of this tornado, was probably sufficient to withdraw the waters from the shores so as to produce the efflux and reflux that was witnessed. Such sudden changes of the level of the waters, are said to have been witnessed before on the lakes. The solution in this case may apply to the whole. It seemed desirable to collect and connect the facts in this case and to publish them, as they prevent a resort to supposed earthquakes, heaving the bottom of the lakes, or change of the level of the shores, of which not a trace is left and not a probability exists. This tornado does not appear to have moved rapidly, but to have derived its force from the great rotatory velocity, as it twisted off trees, breaking them more than overturning them. A lumber wagon was raised into the air and carried a considerable distance. A stick of timber, which required eight men to carry it, was removed to the distance of fifty rods. On the lake, large water spouts were raised, and a great body of water seemed to be elevated into the air. It passed over nearly the middle of this part of the lake, as it was too far from Cobourg on the north side, and from Rochester on the south side, to attract any attention.

2. *Fall of the Water of the Lakes.*

It is well known that the level of Lake Ontario slowly descended through several months of last year. The collector of the port of Genesee, L. B. Langworthy, caused accurate measurements to be made at the mouth of the river, which have been continued by his successor. The level was considerably lower last summer than in several years before; and the level fell till the beginning of this year. About the first of March it began to rise, as shown by the following record from the collector's office.

				Feet.	Inches.
1845.	June	1,	water below top of wharf,	1	0
	Sept.	1,	" " " "	2	1
	Oct.	1,	" " " "	2	6
	Nov.	1,	" " " "	2	9
	Dec.	1,	" " " "	3	1
1846.	Jan.	1,	" " " "	3	4
	Feb.	1,	" " " "	3	4
	March	1,	" " " "	3	2
	April	1,	" " " "	2	9
	May	1,	" " " "	2	6
	"	21,	" " " "	2	3

The melted snows of March, and rains since, have made a rise of more than a foot.

The level of the water has been considerably lower than usual in Lake Erie, and at Detroit and in Lake Michigan, also at Niagara Falls. The same fact is doubtless true in Lake Superior. For the same reason has been operating over all the region of the great lakes. An uncommon drought for more than half of 1845 extended over this whole section. Of course, *far less water than is common, was poured into the lakes.* The cause of the fall is most obvious; and there can be no necessity for a resort to the notion of a regular and periodical rise and fall of these inland seas, or to a supposition of an actual sinking of the bottom of their outlets. While the drought extended over a wide extent of our country, the seasons were wet and rain was abundant in the western parts of Europe.

Rochester, N. Y. May 22 ,1846.

ART. XI.—*On the occurrence of Fluor Spar, Apatite and Chondrodite in Limestone;* by JAMES D. DANA.

THE analyses of corals by Mr. B. Silliman, Jr.,* have shown that although ordinary corals consist mainly of carbonate of lime, there is present a small proportion of phosphates, and fluorides, with some silica, alumina and oxyd of iron. It is also probable, from some trials by Mr. Silliman, that these constituents exist also in many shells.

From the results obtained in these analyses, it appears that the fluorides and phosphates amount, on an average, to about ¼ per cent, or 0·25 parts in a hundred parts of coral; and the amount in the same manner of the phosphates, is 0·05 per cent. A cubic foot of coral, as deduced from the average specific gravity ascertained by Mr. Silliman, weighs 157 pounds. Consequently in each cubic foot there are 6¼ ounces of fluorides, and 1¼ ounces of phosphates; in each cubic rod, 1700 pounds of fluorides, and 340 pounds of phosphates. These fluorides are fluorides of calcium and magnesium, and the phosphates are phosphates of lime and magnesia. In the same manner we ascertain that the amount of fluorides in a reef of coral, a mile long, half a mile wide and a hundred feet deep, amounts to more than 500,000,000 pounds. The proportion of silica is a little less than that of the fluorides.

Late geological researches have placed it beyond doubt, that the various limestones consist mainly, like coral limestone, of animal remains, among which corals, in many instances, hold a conspicuous place. These limestones often contain crystallizations of fluoride of calcium (fluor spar); and in other beds which have evidently been acted upon and crystallized by heat, there are also apatite (phosphate of lime), and chondrodite, (composed of fluoric acid, magnesia and silica). Moreover these are the most common minerals of these limestones.

The above deductions supply us with a full explanation of the origin of these minerals. The fluorine, phosphoric acid, lime, magnesia and silica present, are adequate for all the results, without looking to any other sources. Instead therefore of being extraneous minerals introduced into the limestone rock, their ele-

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* See the volume of the Exploring Expedition on Zoophytes, p. 712; and this Journal, Second Series, vol. i, p. 189.

ments at least are an essential part of its constitution; and they have been separated from the general mass by a segregation of like atoms under well known principles, and it may be, arranged anew, in some cases, according to their affinities. Fluoride of calcium may crystallize out when under water, without much or any heat; and it is an interesting fact that this fluoride has been lately proved by Mr. G. Wilson, to be soluble, to some degree, in pure cold water.* Mr. G. Wilson has also shown that fluorides actually exist in seawater, as had been suggested by Mr. Silliman, some months before the discovery, in his memoir on the composition of corals. Apatite and chondrodite require heat, as they are found only in *granular* limestones. The chondrodite is not supposed to exist as such in coral, but to form from the mutual action of its elements, (which are present) during the slow action of the heat that gives the crystalline character to the limestone.

The magnesia of magnesian limestones is not attributable to the corals, as the proportion obtained by the analyses is less than one per cent.† It is derived probably from a foreign source; and this may be true, in part at least, for the magnesia of the chondrodite, although there is enough of this constituent present for a large amount of this mineral. The silica may also be in part foreign, or may proceed from the earthy impurities which were mixed with the limestone at its formation.

New Haven, May 1st, 1846.

Art. XII.—*Description of a peculiar arrangement of muscles in the Glass Snake,* (Ophisaurus); by W. M. Carpenter, A. M., M. D., Professor in the Medical College of Louisiana.

Both in the Old and the New Worlds, there are species of reptiles called Glass Snakes, *(serpent a verre,)* on account of their extreme fragility. These animals, belonging to different species, appertain however to the same group. The animal called by this name in Europe, is the Anguis fragilis of Linnæus, whilst in this country, several species of Ophisaurus are confounded, by the people, under this common name.

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* See Chem. Gazette, No. 85, May 1846, p. 183; and *beyond*, in this volume.

† See this Journal, New Series, i, 189, 198.

These animals have the external form of serpents, but resemble the lizard family in general structure. They constitute the transition type between the Lacertian and Ophidian reptiles. The genus Ophisaurus owes its name to this circumstance, (Οφις, *serpent*, σαυρος, *lizard.*) It includes several species inhabiting the southern parts of the United States, principally the pine forest and prairie regions. They have about 150 vertebral bones, about one third of which belong to the body and two thirds to the tail; the body is consequently very short when compared with the tail.

All of the species receive indiscriminately the name of Glass snake from the extreme fragility of their tails. A very slight stroke with a small rod, or trifling violence inflicted by any other means, will cause the separation of a part of the tail from the body, and the tail will sometimes break into a number of pieces. The body and attached parts continue to live, and in process of time the lost portions are replaced by a new growth.

If we examine the parts separated, in an animal which has been thus broken, or what is preferable, drawn asunder, several little conical and pointed fleshy processes, may be observed, surrounding the vertebral bones, and projecting several lines beyond their articulating surfaces, and which must have been drawn out of cavities in the muscles, that correspond in position on the adjacent vertebral bones.

Fig. 1.

In figure 1, I have endeavored to represent an enlarged view of this appearance. Lines drawn across the figure from the points a to a', b to b', c to c', and d to d', may represent the position of the separated articulating surfaces of the adjacent vertebræ, which, when in their natural positions, would of course be in contact; and it is easy to see that when these are in contact, the conical muscles, which project so much beyond them, must fit into corresponding cavities of their own size, in the muscles corresponding in position with them on the next bones. If one of the vertebræ is examined separately from the rest while surrounded by its muscles, it will be seen that each vertebral bone has a series of these muscular cones around each of its extremities, and projecting beyond its articulating surfaces, in a direction parallel to the axis of the bone; one set projecting forward and the other backward. Further examinations show that these two sets of muscles are connected together, and in fact that they are composed of the same fibres or fascicles, which, having slight attachments about the middle of their length to the bone, extend forward to form the anterior series, and backward to form the posterior series of conical muscles. Each of these cones is formed by the union of two sets of muscular fibres, which are slightly oblique to each other, and which meet at a very acute angle; and the same fascicles which, by their anterior projection, form the cone standing *forward*, are prolonged in the opposite direction, and by meeting with the oblique fascicle lying next to them, form the cones which project *backward.* Each of these conical muscles contains a conical cavity corresponding to its outward form, for the reception of the muscle next behind it. This arrangement I have endeavored to represent in the middle portion of fig. 1. Lines drawn from *b* to *b′* and from *c* to *c′*, would indicate the situation of the ends of the bone. The white lines which run a little obliquely back and forth, and meet to form the zigzag series, indicate the relative position of the different fasciculi of muscular fibres, which constitute the series of muscles that surround each of the vertebral bones. Each of the fascicles has a point of attachment to the bone near its middle.

In order to analyze the arrangement of these muscles and the direction of their fibres, it will be necessary to describe the bones around which they are situated.

Fig. 2.

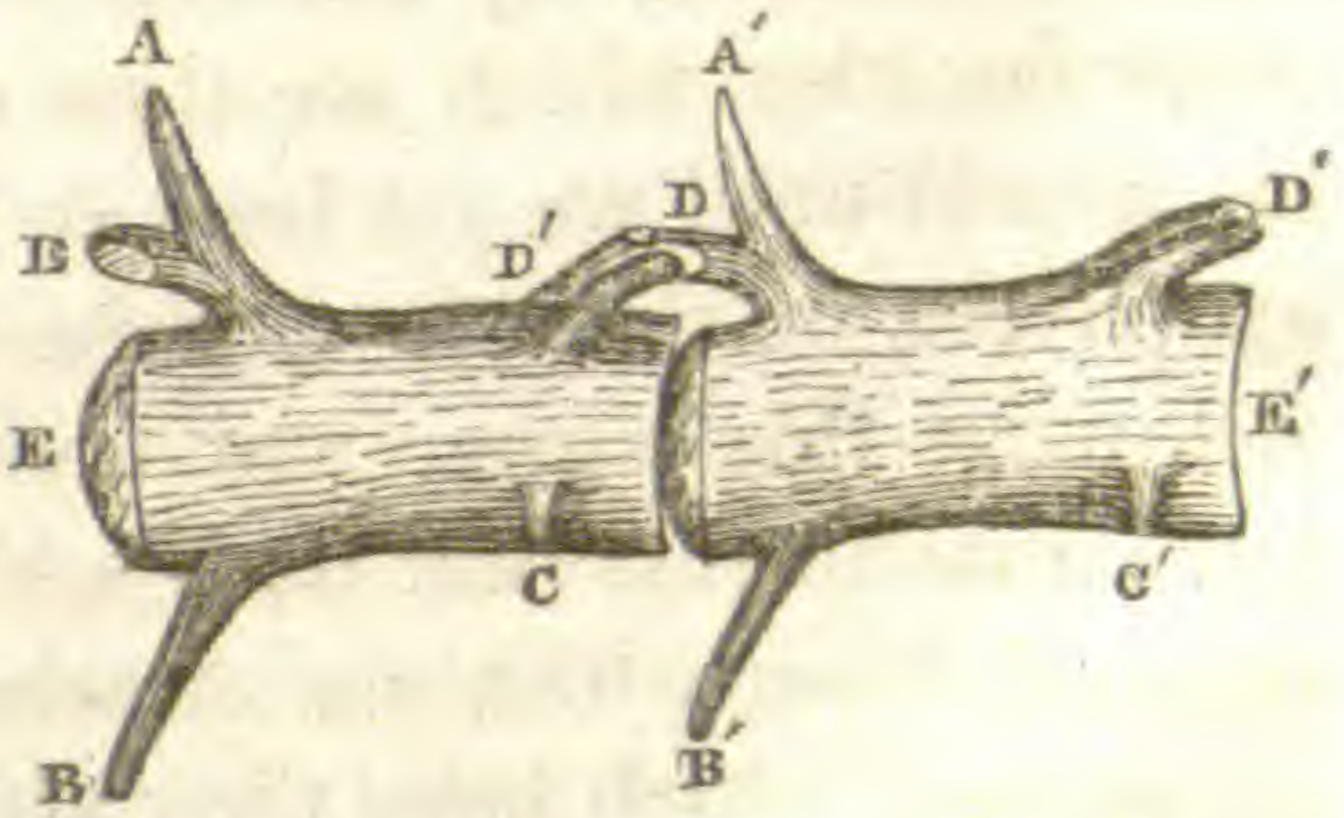
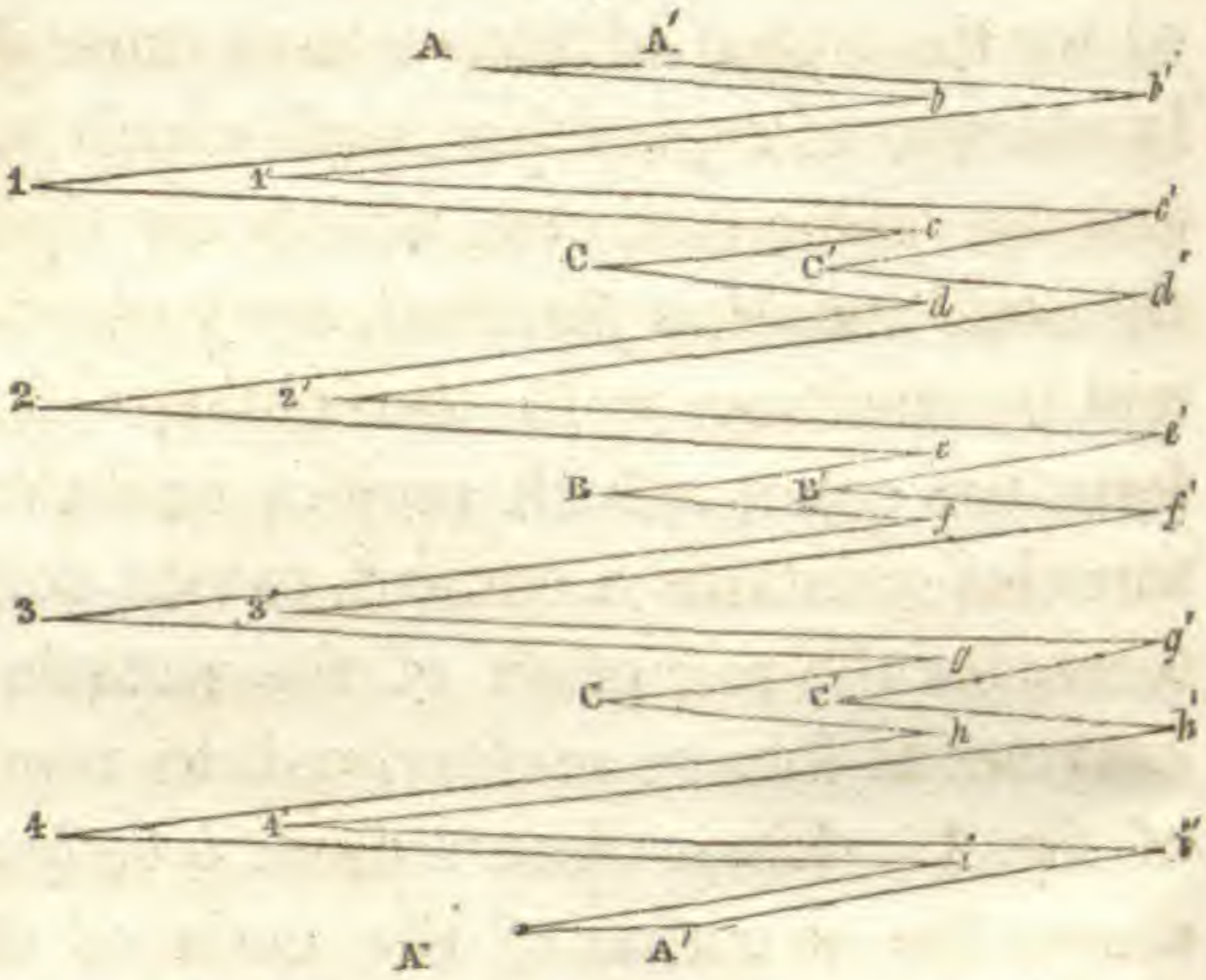


Fig. 2 represents an enlarged view of two bones in their natural position. The anterior articulating surface is concave, the posterior convex; they are covered with a smooth cartilage, and are susceptible of very free motion; they are represented by E and E′. A and A′ are the superior spinous apophyses, between the crura of which passes the superior spinal canal, containing the spinal marrow. B and B′ are the inferior spinous apophyses, between the crura of which passes the large artery. C C′ are the transverse apophyses—D and D′ are the oblique articulating apophyses.

These bones are but slightly attached to each other by ligaments. There are rudiments of capsular ligaments, which are very thin fibrous membranes surrounding the articulation; and there are a few fibrous filaments passing from one of the spinous apophyses to the other; but they are all so delicate that they would be altogether inadequate to hold the bones together.

Fig. 3.

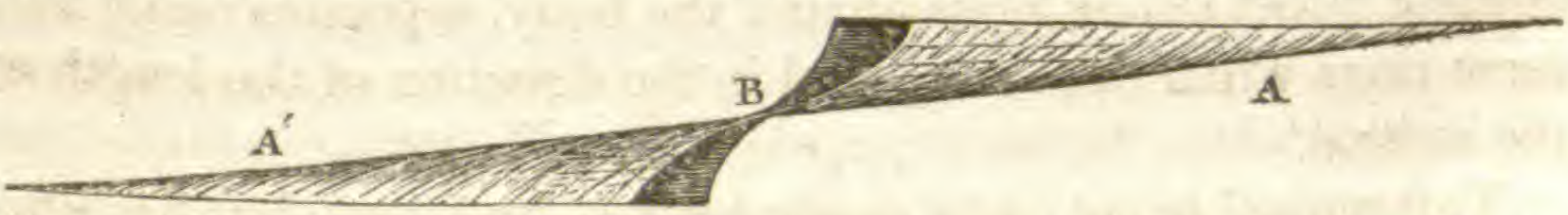


In the diagram, fig. 3, I have attempted to show the relative situation and direction of the muscular fascicles which enter into the composition of the muscles, situated around two contiguous vertebral bones. Suppose the layer of muscles to be detached from the bone and spread out on the paper, beginning at the dorsal median line. Let the line A A′ represent the direction of this line, in which the points of the superior spinous processes are represented by the points A and A′. Starting from the spinous apophyses A and A′, the first fascicle on each side of the median line, runs obliquely forward and downward, and may be represented by the lines A*b* and A′*b*′, and are met at their anterior extremity by fascicles 1*b* and 1′*b*′; running with equal obliquity, forward and upward. The fascicles *b*1 and *b*′1′ are met at their other extremities by fascicles *c*1 and *c*′1′; and so on with the other fascicles which are thus connected, and may be followed on around until we get back to the starting points at the spinous apophyses, on the side opposite to that on which we commenced following this zigzag and continuous series. These fascicles have attachments near their middle to the bones, with the exceptions of those which are attached to the spinous and transverse apophyses, which have their attachments by one of their extremities. Thus in the diagram fig. 3, the points A A′, B B′, C C′, represent respectively the superior spinous, the inferior spinous, and the transverse, apophyses, and it will be seen that the fascicles start from them respectively.

Now each of the fascicles of this series being met at each of its extremities on alternate sides, by other fascicles at acute angles, unite with them to form the hollow little cones already mentioned. Each of these cones is received and exactly fits into the hollow of that which stands next to it in the direction of its point; and in turn it receives the point and body of that which stands next to it in the direction of its base. Each of these cones may perhaps be one third or one fourth as long as the entire fascicles of which it is composed.

Some of the fascicles being attached near their middle to the bones, have both of their extremities free, and it is by these free extremities that the conical muscles, in each direction, are formed; while those fascicles which have their attachment to the spinous and transverse processes, are attached by their posterior extremities, and from them project only forwards, and having only one free extremity, enter into the formation of only one set of muscles. The points of attachment which are in the middle of some of the fascicles, are common to both the anterior and posterior sets of muscles. The fascicles surrounding a bone have each a single point of attachment to that bone, and are not at all attached to any other bone; and the series of muscles surrounding a bone, has fibrous or muscular attachments to this bone alone, and has no fibrous attachments to any other tissues, excepting a very slight one on its contour, to a thin fascia which surrounds the series and binds it together.

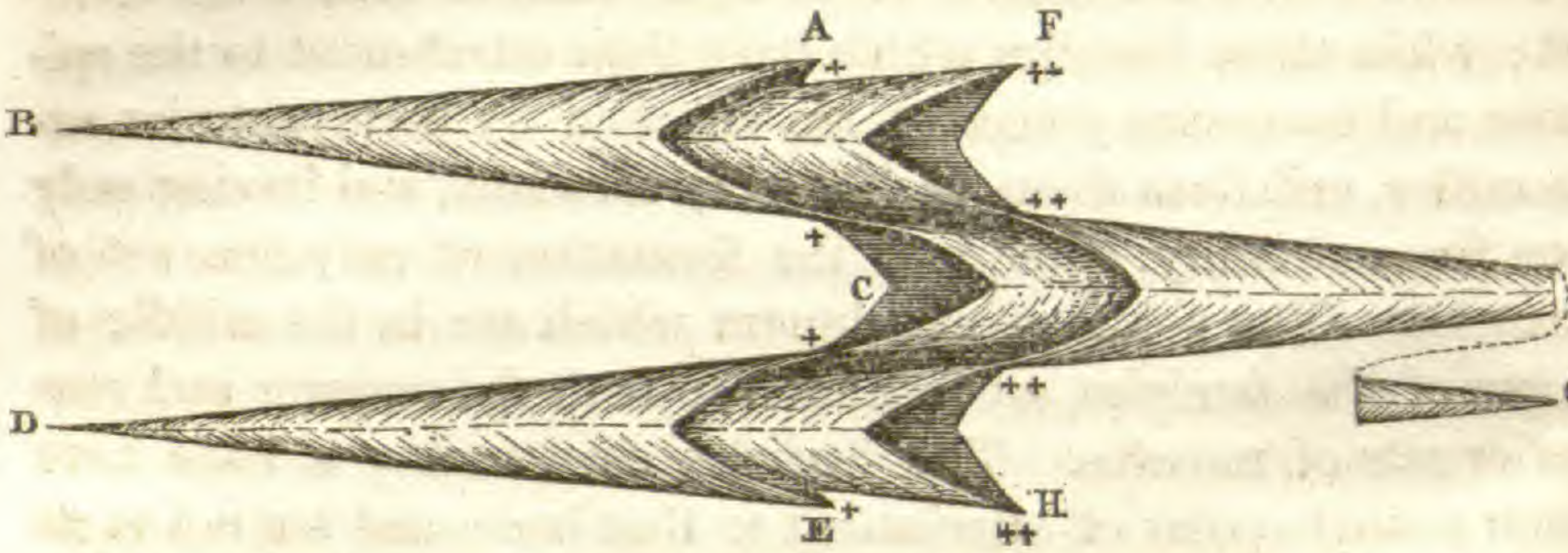
Fig. 4.



In fig. 4, I have endeavored to show the arrangement of the fibres in each of the fascicles, which, in the middle portion, is a flattish muscular membrane, and for a portion of its length towards each extremity, forms the lateral half, A and A′, of a hollow muscular cone, the concavity, in the two, presenting in opposite directions, and which meeting with other similarly arranged fascicles, completes the cones which stand in opposite directions. The fascicle is attached to the bone by the middle at B.

In fig. 5, I have endeavored to exhibit the manner in which the systems of muscular cones, connected with two contiguous bones, mutually receive and are received by each other. The muscular arrangement A B C D E, belongs to one bone, while the arrangement F G H, belongs to the adjacent bone. The points of attachment of these two muscles to their respective bones, may be represented by the points * and * *. The cones F and H, of the muscles of one bone, fit into the cones A B C and C D E of the other, while the cone C of the latter, fits into the cone G of the former. Thus the muscular cones of the successive bones, mutually invaginate into each other, where they are retained, not by fibrous attachments, but merely by fitting nicely into each other, and by the harmony of their contractions one upon another.

Fig. 5.



The muscles in their natural position, surrounding the bodies of the bones, form the fleshy cylinder of the animal, as at *f*, fig. 1. This is surrounded by a thin fascial sheath, which lies immediately under the skin, as represented at *e*, fig. 1, and which constitutes the principal means by which the bones and muscles are held together in the direction of their length; as the skin, though forming rather strong rings around the body, separates easily into these rings when force is applied in the direction of the length of the animal.

This animal is not only easily broken by blows, but has likewise the power, when caught, of casting off the part of the tail which is held. It is also said that the Anguis fragilis of Europe, possesses the same power. This power may be accounted for, by supposing the animal capable of exercising separate and distinct control over the contractions of each of the muscular cones. This being the case, if the animal contract all the invaginated cones belonging to a bone, and does not contract the invaginating cones, it is evident that it would cause a partial loosening and drawing out of the invaginated cones; and as the cohesion of this invaginated arrangement seems to be one of the principal forces that holds the different segments together longitudinally, these would then separate at the point where this force is removed.

It is a popular error which supposes that the separated joints or segments reunite, and that they will come together even if separated to a considerable distance. The spinal marrow and large artery run through the entire length of the animal, the former occupying a canal which passes between the crura of the superior spinous apophyses; the latter in one which lies between the crura of the inferior spinous apophyses. In separating the bones from one another, these important organs are of course broken, and the death of the separated segments is an inevitable consequence. The animal, however, acquires a new tail by growth. When first healed the animal ends in an abrupt truncation, which is covered with small scales, arranged in concentric circles around its centre; but in course of time, this truncated extremity begins to receive a conical shape, which gradually takes a more projecting and tapering form, the circles of scales then assume the position of rings, which surround and cover it; and by slow growth the tail acquires about its wonted length.

This arrangement is interesting, principally, from being a new form and application of the muscular structure. Notwithstanding the modifications which the muscles undergo, in assuming this arrangement, we may fix upon the particular muscles of which the fascicles are formed. The muscles which form these fascicles are, principally, the interspinales, the longissimus dorsi, the inter-transversales, and some others.

ART. XIII.—*Observations on the more recent researches in the Manufacture of Iron, (continued;*)* by Dr. J. LAWRENCE SMITH, of Charleston, S. C.

IN the last article on this subject, the operations of the blast furnace alone were alluded to, and among the statements then given, was that of the composition of the gas taken from the mouth of the furnace; which gas contained about 24 per cent. of carbonic oxide, this representing a large portion of the combustible used, which is lost in most of the furnaces now in operation in this country.

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* See this Journal, Second Series, i, 170.

M. Ebelman states that the combustion of the gas passing from the mouth of the blast furnace is equal to from $\frac{62}{100}$ to $\frac{67}{100}$ of the calorific effect of the coal used, and MM. Bunsen and Playfair set it down as $\frac{90}{100}$, which last I am inclined to believe is rather too large a fraction; they spoke of the furnace worked with bituminous coal, and Ebelman had allusion to one worked with charcoal. Without being able to decide exactly what portion of the combustible of the blast furnace is lost, it is sufficient to know that it is far greater than that consumed, to lead at once to the employment of means bringing into use this waste combustible.

The employment of the heat lost from the mouth of the blast furnace, for the purposes of metallurgy, &c., has been claimed by many as having been used by them since 1834. The following are some of the claimants:—MM. Thomas and Laures, (civil engineers); MM. d'Andelarre and de Lisa, (forge masters at Treveray); M. le Marèchal Marmont, (in Austria); M. Houzeau Muiren, (of Ardennes; and M. de Faber Dufaur, (of Wasseralfingen). All their claims of priority, however, ought to be laid aside, since the operation was performed many years prior to the time that any of them claim to have first employed the lost heat. And as a proof of this assertion, I give the following extract from the Journal des Mines, Juin 1814.—"M. Aubertot of the department of Cher, and owner of furnaces and other works in excellent condition and management, which he superintends personally, made, several years ago, a great many experiments to discover some means of economizing the amount of fuel used in the working of iron, either by endeavoring to introduce the operation by the catalan furnace, or otherwise. He was led to try what could be accomplished by making use of the flame which passed out of the blast and refining furnace. He first employed it for the cementation of steel, in which he succeeded perfectly; then he used it for calcining lime, also for burning bricks and tiles. Afterwards he passed it into a reverberatory furnace, in which the temperature was raised sufficiently to heat the blooms and bars, for hammering the one and drawing the other out. Finally he succeeded in producing all the above effects at one and the same time, by causing the flame to circulate through several furnaces side by side."

In 1834, M. Houzeau Muiren took out a patent for using the waste heat from the mouth of the blast furnace, for carbonizing wood at the furnace of Bievres (Ardennes); in which he states that twice the quantity of charcoal is obtained by treating the wood after his method, than by the ordinary way of burning in the woods. By the heat lost from the furnace, 100 parts of wood gave 35 of charcoal, and from 40 to 45 of *charcoal roux* (half burnt wood).

But after all, it is not to those who first applied this lost heat to economical purposes, that we are indebted for the practical information that is now in our possession; for had they made their arrangements so as to exhibit an undisputed advantage arising out of its adoption, it would not have been so tardy in its progress.

It is to M. de Faber Dufaur, superintendent of the iron works at Wasseralfingen in the kingdom of Wurtemburg, that most of the credit is due for the present method of converting pig into wrought iron, by using and burning the gases that escape from the mouth of the blast furnace. The best idea that can be given of the manner in which the operations are conducted in the above works, and the advantages accruing therefrom, is contained in the following short extract from a letter written by M. Grouvelle to M. Dumas.*

"The establishment at Wasseralfingen is supplied with ore, three-fourths of which is a hydrated oxide of iron, and the other fourth is an ore in grains. The influence of the first species of ore gave to the pig so bad a quality that it was used altogether for castings. M. Dufaur, by his processes, without altering the operations of the blast furnace, now obtains from the pig a wrought iron of superior quality.

"The first gas furnace put in operation by him was a refining furnace, into which the pig metal was run as it issued from the blast furnace, where the refining was executed with the air of the hot blast. From this the most beautiful results were obtained, and it worked regularly during the year 1837. In 1838 he erected a puddling furnace; and finally in 1839 he completed his magnificent system for the fabrication of iron, by constructing a furnace for re-heating and welding."

At Wasseralfingen there are now turned out annually, one million pounds of wrought iron in various forms, made in these new furnaces, and owing to the deficiency of moving power, all the pig cannot be worked up. This operation of refining iron

* Comptes Rendus, 1841, p. 382.

by the combustion of gas without any other fuel, has been in successful operation at the above locality for several years, and it has been followed with a great improvement in the quality of the iron and has reduced the loss to one fourth of what it was originally.

This method of refining the pig has also been in active operation in a number of places, and whenever properly executed, is always attended with economy and success. M. d'Andelarre, in one of the departments of France, in a letter states, "our puddling furnaces, heated altogether by the gas lost from the mouth of the blast furnace, has been attended with the most complete success, which rarely happens in the first attempts at the application of any improvement, which most generally require long experience. We lighted up our furnace on the morning of the 5th, and put in the first charge at 11 o'clock on the morning of the 6th, and shingled the same at three-quarters past 12. The accomplishment of the results so quickly passed our expectations, resulting in

"1st. An economy of the total amount of fuel used in the refining of iron, (which, in a furnace with two doors, amounted, in twenty-four hours, to 6,000 pounds bituminous coal, costing twelve dollars.)

"2d. Improvement in the quality of the iron.

"3d. The loss was very small, being 5 instead of 20 per cent., which it is by the old processes.

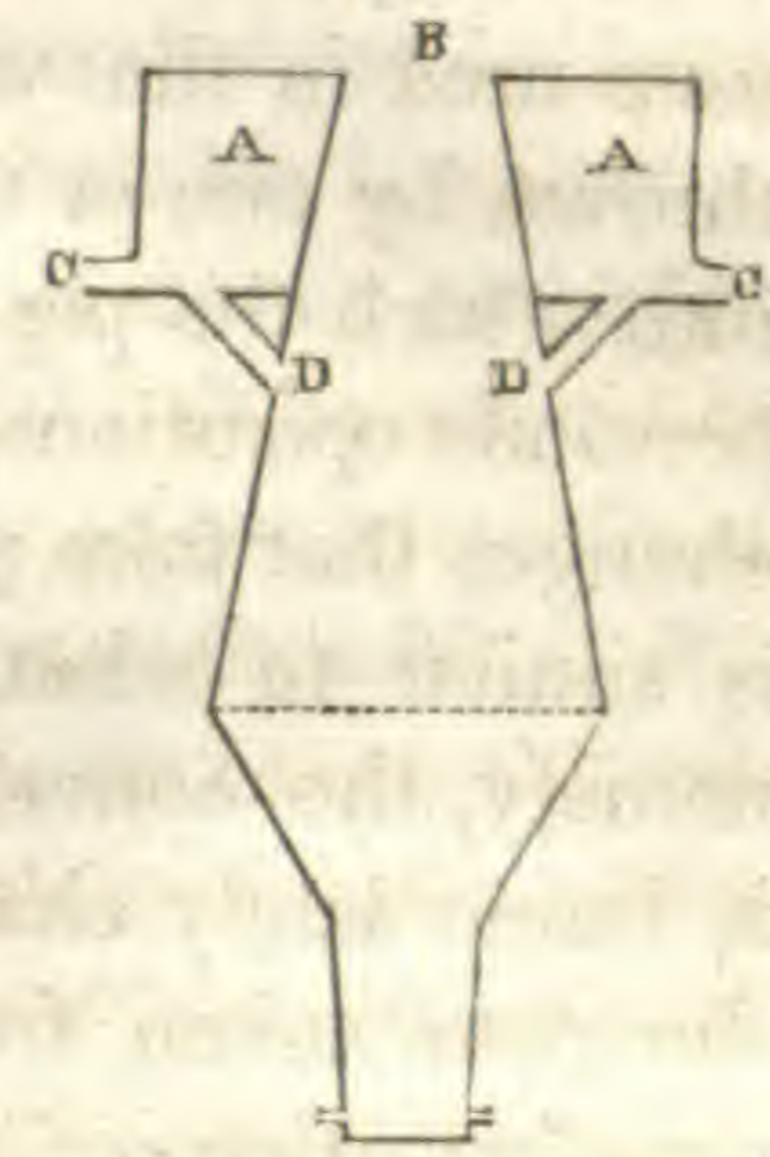
"4th. The operations of the furnaces are much improved."

Here we see that the experience of M. d'Andelarre accords exactly with that of M. Dufaur, and already have Russia, Prussia, Sweden and Germany sent commissioners to Wasseralfingen, to study the processes as they are there carried on. The government of Wurtemburg have opened their works to the inspection of all who may wish to make themselves acquainted with their character.

The advantages arising from the employment of the waste gas from the mouth of the blast furnace, is no longer problematical, and as some of those interested in this matter may not be acquainted with the method by which the gas is collected and employed, a few words explanatory of it will not be out of place.

The gas, as it rises through the fire room of the furnace, containing from 60 to 80 per cent. of the combustible effect of the fuel used, is made to pass into a chamber surrounding the upper and outer part of the fire room, some idea of which may be formed by the representation in fig. 1. B, is the mouth of the furnace; A A, gas chamber surrounding the upper part of the fire room; D D, pipes connecting the fire room and gas chamber; C C, pipes to carry off the gas, which is drawn out by means of blowing cylinders and forced into the refining, puddling or other furnace, through a number of small orifices alternating with other orifices, through which a cold or hot blast of air is thrown, that serves to keep up the combustion of the gas when once united; and by regulating the supply of air by means of stop-cocks, the maximum of heat can be obtained. In order to arrive at the maximum of heat, just sufficient air should be admitted to burn all the carbonic oxide and hydrogen contained in the gas coming from the blast furnace. If the amount of air be too small, some of the combustible gases pass out unconsumed; if too great, the excess cools the furnace, and at the same time oxidizes the metals undergoing refining. The regulation of the supply of the blast is of the utmost importance, and is said to be easy of accomplishment.

Fig. 1.



The differences between the reverberating furnaces worked in this way and those in which coal is used, is that carbonic oxide with a little hydrogen is the fuel, and it is burnt by a full supply of air. It is hardly necessary to say more of the advantages that are to arise out of this important change in the working of iron; for there is no expense for fuel in the refining of the pig, as the gaseous combustible issuing from the mouth of the blast furnace is more than sufficient to refine all the pig made from the furnace. The quality of iron is also improved, as none of those impurities contained in the coal and other fuel can interfere in the working of the iron.*

The sooner these modifications are introduced into our furnaces, the sooner will we be able to place iron in the market at a price to compete with that coming from any other quarter of

* If I mistake not, the Dufaur patent has been taken out in this country by Mr. Detmold, and has already been applied to one or two furnaces.—J. L. S.

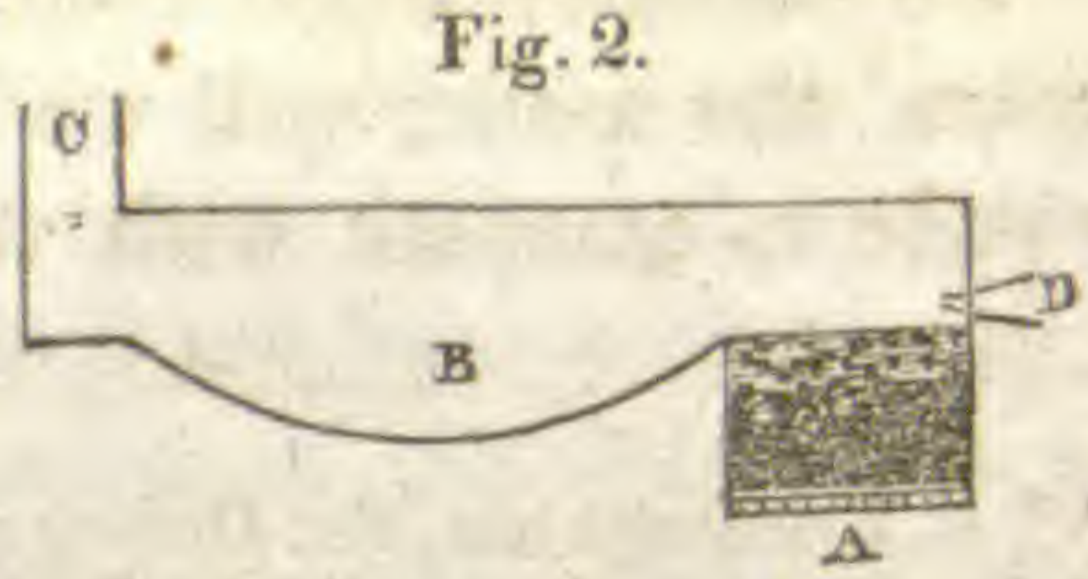
the world, and entering our ports free of duty; at the same time it will increase the value of those works whose wood-land has been diminished by a too rapid and improvident use of fuel.

I next pass on to make a few remarks about the *refining furnace* used in the working of iron. In these furnaces the air is thrown by one or two tuyers, into a crucible filled with charcoal, into which the pig to be refined, along with scraps coming from previous operations, is placed in a certain relative position. The changes that take place by the reaction of the air upon the coal, is similar to what occurs in the lower part of the blast furnace, namely, the conversion of the oxygen into carbonic acid, which is immediately changed into carbonic oxide. The analyses of the gases taken from the centre of the furnace, prove that the transformation of the oxygen into carbonic acid corresponds to the position where the workmen constantly place the iron that is about to be forged, and this is just what we should expect as it is the point of maximum temperature.

Ebelman states that the atmosphere which surrounds the melted iron, contains hardly a trace of carbonic acid, either in the blast or puddling furnace; this being contrary to the opinion which is generally admitted, that the decarbonization of the iron takes place by the action of the air during the melting of the pig, but it would appear that this reaction is attributable to the protoxide of iron covering the surface of the mass undergoing refining. In the second period of refining, in the puddling properly speaking, it is easy to deduce from the analyses of the gas, that there is oxidation of a considerable portion of the iron by the oxygen of the air thrown in at the tuyer.

Here again much of the fuel passes off under the form of carbonic oxide, thereby causing considerable waste. Of late years a modification has been introduced into the refining furnaces, even when the waste gases from the blast furnace are not employed; a modification by which none of the combustible is lost. A few words will suffice to explain how this is accomplished.

Fig. 2.



All the furnaces are modifications of the reverberatory furnace. The fuel is placed upon the grate A, (fig. 2,) and ignited by air thrown in from below the grate, by a bellows or otherwise. The air in traversing the ignited coal is first converted into carbonic acid, and then, if the bed of coal be thick enough, this last will be changed into carbonic oxide. As this however is generally not the case, a part of the carbonic acid passes beyond the upper surface of the fuel without having undergone a change, particularly if the blast from below has been strong and abundant. By this operation the chamber B becomes heated, and a mixture of carbonic acid, carbonic oxide, nitrogen, and a little hydrogen passed out of the flue C. The object of the metallurgist, however, is not to permit any carbonic oxide or hydrogen to escape combustion, but to endeavor to add to the heat of the furnace, that heat arising from the combustion of these two gases. This is readily accomplished by throwing in a second blast of air, through a number of small orifices just above the surface of the fuel, D; this blast to be regulated as required.

By this process we re-create, as it were, the maximum intensity of heat (which first shows itself at the lower part of the fuel on the grate, just where the air becomes converted into carbonic acid,) and in the chamber B, where it is most wanted; for the amount of heat rendered latent by the reduction of the carbonic acid into carbonic oxide, is rendered sensible by the reproduction of the former.

The advantages arising from this method of burning the fuel, are important. In the first place, the heat is diffused over a larger space, thereby heating more uniformly the metal, than when it is placed in the midst of the fuel. Again, fuel of the most inferior quality can be made use of, and as evidence of this in some trials made at Audincourt, it was proved that the reverberatory furnace could be heated to whiteness by burning the gas, and the pig melted and puddled, when a mixture of charcoal dust and earthy matter was made use of as fuel.

Ebelman, whom I have so often quoted in these articles, and who has certainly made the best series of scientific researches upon the subject, says that instead of employing the action of air upon an excess of charcoal to produce the combustible gas, the vapor of water may to an extent be substituted, which produces, in contact with burning charcoal, carbonic oxide and hydrogen.

The heat of the combustion of equal *volumes* of hydrogen and carbonic oxide is about the same, and it can be easily deduced that the decomposition of the vapor of water by the charcoal, determines an absorption of latent heat, equal to that which is produced by the transformation of the same volume of carbonic acid into carbonic oxide. The vapor of water alone passed through the ignited coal produces all the effects just mentioned, but the absorption of latent caloric is so great as to cause the operation to cease in a few minutes. By projecting, however, a mixture of air and the vapor of water through the coal, the operation is said to be carried on advantageously.

It was my intention to have remarked at length about the effects of the hot blast, but it is now so generally admitted that the hot is to be preferred to the cold blast in reducing the iron from the ore, and bringing it to its most refined state, that any thing on the subject at this time would be superfluous. All that is important to make known upon this subject, is the results lately arrived at by M. Scheerer* as to how it is that hot air produces such remarkable effects in the blast furnace.

By calculations based upon his own experiments as well as those of others, he was led to the conclusion, that the most elevated temperature that charcoal could produce in burning in air, is 2571° Cent., which is that at which platinum melts. This temperature is situated in the middle of the space upon which the air is projected, and it goes on diminishing towards the exterior, so as to form a space for melting, the center of which is at 2571° and the exterior at 1550° Cent. When the hot blast is made use of, the temperature of the center does not change, but the portion heated to 2571° becomes more extended. The exterior of the mass which was at 1550° while using the cold air, acquires when the hot blast is employed, a temperature as many degrees higher as there is difference between the temperature of the two blasts; for instance, if the temperature of the air be 280° C., that of the exterior of the heated mass will be 1830° C.—if 300° C., the latter will be 1850° C.

Thus the influence that hot air exercises, is to extend the space of fusion, which is twice as great with the air at 300° C. as it is when the air is at 0° C.

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* Pogg. Ann. lix, p. 508.

SCIENTIFIC INTELLIGENCE.

I. Chemistry.

1. *Ozone.*—For some years, Prof. Schönbein, of Basle, has been engaged in experimenting on the cause of the peculiar odor developed by electricity; during the electrolysis of water, the oxygen given off is mixed with a small quantity of a volatile odorous substance; to this he has given the name of *ozone.* For some particulars of its production, see this Journal, Vols. XLI and XLIX.*

This substance he supposed to be a halogen body, analagous in its reactions and affinities to chlorine and bromine, and indeed it has many points of resemblance; it destroys vegetable colors, decomposes bromide, iodide and ferro-cyanide of potassium, and acts upon the metals.

He regarded it as constituting the base of nitrogen, which he supposed to be a compound of ozone and hydrogen, analagous to the chloride of hydrogen. He supposed it to be a secondary product of the electrolysis, and formed by the reaction of the nascent oxygen on the nitrogen of the atmospheric air dissolved in the water.

M. Schönbein was subsequently enabled to produce this body by purely chemical means; when phosphorus, at ordinary temperatures, is exposed to *moist air*, ozone is always generated.† This reaction is best observed by introducing into a large glass vessel, a piece of phosphorus one or two inches long, and sufficient water to partially cover it; the whole may now be exposed for 24 hours to a temperature of 68° to 75° F., when the air will be found very highly charged with ozone.

From its supposed nature as the base of nitrogen, this body has attracted considerable attention from chemists, and has been made the subject of much experimental research, as well as a great deal of theorising and speculation. It has been particularly examined by M. Marignac and Mr. Williamson.

The former chemist has shown that ozone is generated by the electrolysis of dilute sulphuric acid, independently of the presence of nitrogen; it being produced equally well in a vessel exhausted of air.‡ M.

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* See also, Schönbein Archives de l'Electricité No. 15. Tom. iv. pp. 333–454; No. 17, Tom. v. p. 11–23, and No. 18, Tom. v. p. 337–342. Marignac, 17. v. p. 5–11; besides other authorities quoted farther.

† The peculiar odor of phosphorus is probably due entirely to the formation of this new substance.

‡ In one experiment, water acidulated by sulphuric acid was decomposed in a vessel, from which the air was completely excluded. After the decomposition had

Marignac also instituted a series of experiments on ozone produced by chemical means; air was made to pass through a long tube containing phosphorus, and thus it became sufficiently charged with ozone for the purposes of experiment. He found that perfectly dry air is incapable of generating this substance, and also that air freed from oxygen by passing over ignited copper, produced no trace of it; but if a very little oxygen (insufficient to support combustion for a moment,) is present, ozone is produced with the same ease as in ordinary air. Pure oxygen, nitrogen or hydrogen alone, do not produce it, but if a small quantity of oxygen is mixed with hydrogen, ozone is formed with great rapidity, on passing the mixture over phosphorus.

Air impregnated with ozone looses entirely its characteristic properties, if passed through a tube heated between 570° and 750° F. This principle is absorbed by water, but not by oil of vitriol, ammonia or chloride of calcium. If the air is passed through a solution of iodide of potassium, it loses its odor, and the salt is decomposed with the liberation of free iodine. Some iodate of potassa is also found in the solution.

Ozone is readily absorbed by the metals. If the ozonized air is passed through a glass tube containing silver in a porous form, (from the decomposition of the acetate by heat,) it loses its peculiar odor, and the silver is converted into a blackish brown substance, which, when thrown into water, gives off oxygen gas with effervesence, and the remaining substance has all the characters of ordinary oxide of silver.

These curious results, many of which were previously obtained by Schönbein, prove that nitrogen is not concerned in the formation of this substance, and seem to show that these peculiar reactions are owing to oxygen in a loosely combined state.

Mr. Williamson's experiments confirm these observations, and go to prove that it is a compound of oxygen and hydrogen. In his experiments, the oxygen from the electrolysis of dilute sulphuric acid, was thoroughly dried by passing it over chloride of calcium; the gas thus dried, was passed through a glass tube containing metallic copper, and heated to redness; water was formed abundantly and condensed in the cool part of the tube, and this formation of water continued as long as the process lasted. From this it appears that water is formed by the reducing power of the metal. To remove all sources of error, the oxygen was evolved from the electrolysis of a solution of sulphate of copper, in whose decomposition no hydrogen is set free, the oxygen thus

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been continued for two or three days, and when more than one fourth of the liquid had been driven off in the form of gas, the oxygen was found to be as strongly impregnated with ozone as at the commencement of the experiment.

obtained possessed strongly the peculiar ozone odor. It was now passed over copper (obtained by decomposing the oxide by carbonic oxide,) heated to redness, and water was immediately formed as in the last experiment.

In subsequent experiments, the ozonized oxygen previously dried, was passed through a glass tube heated to redness, by which the peculiar odor was completely destroyed; to this an accurately weighed chloride of calcium tube was fixed, after the gas had been passed a short time, the tube was found to have increased perceptibly in weight.

When the ozonized oxygen is passed through water, it communicates to it the peculiar odor. If this solution is added to a mixture of starch paste and iodide of potassium, a blue color is produced; and when mixed with ferro-cyanide of potassium, this salt gives a blue precipitate with proto-salts of iron. Solutions of lime and baryta give, with a solution of ozone, a heavy and apparently crystalline precipitate.

Mr. Williamson states as the result of his experiments, that ozone is not produced by the action of air on phosphorus, but we cannot admit this, for several reasons. The results of M. Marignac were obtained by the substance formed in this manner, and many of the results obtained by him are precisely the same with those of Mr. Williamson; and these as well as others obtained, cannot be referred to the action of phosphoric acid.

Mr. Williamson's arrangement, which consisted of a tube containing asbestos, on which the phosphorus was deposited by sublimation, was such as completely to defeat the object in view; for although ozone is generated by the action of phosphorus on air, yet it is itself absorbed or decomposed, when brought in contact with a large surface of phosphorus; and this result would especially occur when the phosphorus was heated, as it must have been from the exposure of so large a surface. Our own observations also have shown that something distinct from phosphoric or phosphorous acids, is generated by this process, for after the air enclosed in the globe had been thoroughly agitated and allowed to stand some hours, in contact with a mixture of carbonate of lime and water, it still retained the peculiar odor, and the power of decomposing iodide and ferro-cyanide of potassium.

The conclusion which these gentlemen deduced from their experiments was, that the substance which presents these curious reactions is a compound of oxygen and hydrogen, containing more oxygen than water, and perhaps isomeric with the deutoxide of Thenard. This view was certainly consonant with their results, and indeed they appeared to be inexplicable by any other hypothesis. The oxidation of silver to such a degree, and the conversion of iodide of potassium into iodate of potassa, evince the existence of oxygen in a feebly combined and very active state, while the formation of water by passing it through an ignited glass tube or over heated copper, show that hydrogen is also present. More recently, however, we have a memoir on this subject by MM. Louis Rivier, and professor L. R. de Fellenburg,* which contains many interesting facts.

In their experiments they passed for two hours a series of electrical sparks through a glass vessel containing humid air, and whose sides were moistened with a solution of carbonate of potassa. The air acquired strongly the peculiar odor of ozone; which, by standing some time, disappeared, and the liquid was found to contain *nitrate of potassa.* They then proceeded to examine the ozone produced by chemical means. The arrangement consisted of a tube *a* about three feet in length, in which were placed several pieces of phosphorus moistened with a little distilled water; to one end was adapted a recurved tube, dipping in a bottle *b* which contained milk of lime; by means of an aspirator *c* connected with the other tube *d*, the air was made to pass slowly over the phosphorus and through the milk of lime, at the rate of 10 litres in 24 hours. The ozone thus formed was absorbed by the alkaline fluid, which after 24 hours was removed. After filtration, it was evaporated to dryness, redissolved in distilled water, decomposed by carbonate of ammonia, and the resulting salt again decomposed by a solution of strontia, when it afforded a salt in beautiful needles, which gave the following reactions: with sulphuric acid and brucine, a reddish yellow, and with narcotine a red color; it destroyed the color of sulphate of indigo; rendered brownish-black the protosulphate of iron; its solution in water with pure hydrochloric acid, readily dissolved gold leaf, and from the solution, chloride of tin threw down the purple precipitate of Cassius; some of the salt mixed with bisulphate of potassa, and heated in a glass tube, gave off abundant red vapors, which promptly blanched indigo paper held in the tube.

They next proceeded to distill a portion of the acid liquor produced by the slow oxydation of phosphorus; a very gentle heat was applied, and about one third of the liquor distilled over; the vapors were received in a solution of strontian; at the close of the operation, this had lost its alkaline reaction; a little more strontian was added, and the whole evaporated to dryness; by re-solution and crystallization, a quantity of salt in fine crystals was obtained, weighing about one and a half grains. This salt gave the same reactions as that above, which must be regarded as decisive evidence of nitric acid; the test with gold, and above all the red fumes evolved by the mixture with bisulphate of potassa, place its nature beyond all doubt.

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* Archives de l'Electricité, No. 17, Tome v. 1845.

From these experiments they concluded, that the reactions attributed to ozone, are in reality due to the presence of a small portion of nitrous acid; and they found that air mixed with a very small portion of nitrous gas, acquired an odor similar to that of ozone, blanching turmeric, dahlia and indigo papers, and presenting generally the same phenomena as ozonized air. They supposed that the acid first formed is the nitrous, as pure nitric acid when very much diluted, does not render blue a mixture of starch and iodide of potassium, which reaction is readily produced by the nitrous acid; and that the nitrites formed are converted into nitrates by the absorption of oxygen during the subsequent evaporation.

These experiments seemed to show, that a close relation certainly exists between nitric acid and ozone, and many chemists were disposed to regard them as identical; but the late researches of M. Schönbein* have cleared up to some extent the difficulties which seemed to envelop the subject.

M. Schönbein has suggested, that when water acts on hypo-nitric acid, there is formed besides hydrated nitric acid, a compound having the formula NO^2+HO^2, and which he calls the peroxide of azote and hydrogen. It is to the presence of this in the solution of hypo-nitric acid, that we are to attribute its remarkable powers of oxidation. The same reaction takes place when the hypo-nitric acid is introduced into a flask of moist air.

If having ozonized the air of a jar by phosphorus, we suspend in it a piece of carbonate of ammonia, till the air acquires the property of immediately blueing litmus paper, we shall find that it still retains all the properties of ozone—the peculiar odor, the power of decomposing iodide and ferro-cyanide of potassium. This body can then exist in an atmosphere of carbonate of ammonia, and also, as is found by experiment, in one of pure ammonia.

If we take a portion of hypo-nitric or fuming nitric, and dilute it with water till it loses its color, and having poured a small portion of it into a flask, suspend in the air of the flask a piece of carbonate of ammonia, till the air acquires an alkaline reaction, we shall find that it is capable of decomposing iodide of potassium, and blanching indigo paper, and even of converting a crystal of ferro-cyanide of potassium into the ferro-cyanide in the course of twenty-four hours; in fact it possesses all the properties of ordinary ozonized air. The circumstances under which these reactions are exhibited, do not admit of the view that the oxidizing agent is any acid of nitrogen, and hence M. Schönbein concludes that there exists the compound NO^2+HO^2.

* Archives de l'Electricité, No. 20, Tome V, 1845.

An interesting fact bearing on this, is the manner in which the mixture of hypo-nitric acid decomposes ferro-cyanide of potassium. If we mix in a tube closed at one end, a solution of the ferro-cyanide with an acid solution prepared as above described, and then invert the tube in water, a violent disengagement of gas takes place, which is found to be pure nitric oxide, and the solution contains nitrate of potassa and the ferricyanide.

This decomposition cannot be attributed to the nitric acid contained in the mixture, for we find that pure nitric acid if slightly diluted, does not decompose the salt, and as neither the hypo-nitric nor nitrous acids can exist in the presence of water.

It is well known that ozone decomposes the iodide of potassium, liberating iodine. If to a solution of the iodide, we add the acid liquor above mentioned, an abundant escape of nitric oxide takes place, while iodine is precipitated and nitrate of potassa forms. Pure nitric when diluted with the same portion of water as in the acid mixture, does not decompose pure iodide of potassium.

The results of Fellenberg are certainly possessed of great interest. The production of nitric acid from the elements of the atmosphere by electricity, was long since noticed by Cavendish, and is a well established fact; but that this acid is formed by the action of phosphorus on air, is a new and highly interesting result. That this highly oxidized body should be generated in the presence of phosphorus, seems at first paradoxical; and we can only refer it to that mysterious force, which Berzelius has named *catalysis*, and which is in fact only a manifestation of the law announced by La Place, that "a molecule set in motion by any power, can impart its own motion to another molecule with which it may be in contact." In other words, the phosphorus, while in the act of oxidation, communicates its own peculiar state to the nitrogen, which is thus enabled to combine with the oxygen and generate nitrous acid. This certainly affords us a very striking illustration of that law, and we think that this phenomenon is incapable of explanation on any other principle. M. Marignac has suggested that electricity generated by the oxydation of the phosphorus may be the cause. This however seems improbable, as it has not been shown that it is excited during the process, and the theory rests on the idea that all chemical action is attended by a development of electricity. But when we consider that our most powerful electrical discharges can generate comparatively very minute quantities of ozone, the amount of electricity that can be supposed, under any circumstances, to be generated by the oxydation of a small piece of phosphorus, seems utterly inadequate to the result.

The experiments of Fellenberg, it will be seen, do not really militate against the existence of ozone; they have only shown that in the ordinary processes by which ozone is generated, nitric acid is also produced, and the similarity between the reactions of air mixed with a little nitric oxide, (by which hypo-nitric acid is generated,) and ozonized air, is readily explained by the researches of Schönbein.

In explanation of the production of nitric acid and ozone by the slow oxydation of phosphorus, we may suppose that nitrous or hypo-nitric acid is generated in the manner before suggested, which, by the action of aqueous vapor in the atmosphere, is converted into nitric acid, and the hypothetical peroxide of azote and hydrogen.

Although ozone produced by chemical means is probably always associated with nitric oxide, yet we cannot avoid the conclusion, apparently overlooked by Schönbein, that the ozone generated under certain circumstances, by the agency of electricity, (as in the experiments of Marignac above mentioned,) must be independent of, and free from nitric oxide. This has the odor and all the other properties of ozone produced by chemical means, and it is difficult to suppose that there can be two compounds, one of which is HO^2 and the other NO^2+HO^2, identical in all their properties, and we are hence led to conclude, that, although such a compound may exist in the mixture of hypo-nitric acid and water, it does not exist in the ozonized air, whether this impregnation is effected by the action of phosphorus, or by agitation with the acid solution in question.

MM. Marignac and de la Rive* have recently obtained some results that seem to prove that water is not essential to the production of ozone. They find that if a series of electrical sparks are passed through oxygen, however carefully dried, ozone is formed, and they suggest that ozone may be nothing more than oxygen, to which "a peculiar state of chemical activity" is given by the influence of the electric current. M. Schönbein, however, regards the formation of ozone as a certain indication of the presence of water in the gas, but in quantities so minute as to escape the action of the ordinary hygrometive substances. The gentlemen above quoted however, find that the oxygen evolved from very pure chlorate of potassa previously fused, gave ozone, when exposed to the action of the electric spark, as abundantly and rapidly as moist oxygen.

M. Schönbein's hypothesis, consequently, rests on the assumption that the gas obtained as above and apparently perfectly dry, still contains water. The suggestion that it is modified oxygen, is one of great interest, and derives some weight from the recently observed facts re-

* Archives de l'Electricité, No. 18. Tome v. 1845.

garding the allotropism of elementary bodies; and particularly the late researches of Draper on the allotropic condition of chlorine.* If oxygen, by the influence of the electric fluid assumes a state of exalted energy and chemical affinity, we are furnished with a key to the *modus operandi* of electricity, in causing many chemical combinations. But in a science which is based on experimental knowledge, we must carefully avoid deducing our conclusions from isolated experiments or theoretical generalizations, however elegant those deductions may appear; and in the case of ozone, very careful investigations, performed with the most rigid exactness, are required before we can admit such a great and interesting conclusion.

At present, then, we agree with Prof. Schönbein, that the great weight of evidence rests with the view that it is a deutoxide of hydrogen, which, although differing from the deutoxide of Thenard, has yet many striking points of resemblance; both bleach powerfully, both transform many protoxides to peroxides, (as, for example, protoxides of calcium and barium,) both transform sulphurous to sulphuric acids, and are decomposed by heat and many organic substances.

With regard to the late results of Marignac and de la Rive, M. Schönbein remarks: 1. Ozone has so strong an odor, that extremely small quantities are capable of affecting the olfactory nerves. 2. Quantities of ozone by far too minute to be ascertained by weight, still perceptibly color the test paste.

From this it follows that a quantity of aqueous vapor, too small to be sensible by our most delicate hygroscopic tests, may generate so much ozone as shall be sensible both to the smell and the iodine test.

We have thus endeavored to give a brief abstract of the present state of our knowledge with regard to this subject, and would refer the reader who wishes to examine the subject more thoroughly, to the authorities already quoted. T. S. HUNT.

2. *Quantitative determination of Urea in Urine;* by W. HENTZ, (Pogg. Annalen, No. ix, 1845, and Chem. Gazet., Jan. 1846.)—His method is based upon the fact that urine when mixed with sulphuric acid and heated, has all of its urea decomposed, with the formation of sulphate of ammonia. Take two or three drachms of urine, and heat it with about two drachms of sulphuric acid, until all evolution of carbonic acid ceases, not allowing the temperature to exceed 180°. The liquid is next filtered into a porcelain dish, and most of the water evaporated; then add twenty drops of muriatic acid, and a sufficient quantity of chloride of platinum and alcohol mixed with ether. Allow the mixture to stand for some time; collect the double chloride, and from it estimate the amount of ammonia.

* See this Journal, vol. xlix. p. 346.

The potash, free ammonia, and uric acid of urine, will interfere slightly with the accuracy of this result, but even this cause of error can be avoided, by first adding to another weighed portion of the urine, some chloride of platinum with three volumes of alcohol and one of ether; which will give the double chloride of the potash and free ammonia contained in the urine, that can be subtracted from what was given by the reaction of sulphuric acid. The error arising from the uric acid is seldom more than $\frac{7}{10000}$; and this acid may be separated from the urine prior to adding the sulphuric acid, by treating the three drachms of urine with thirty drops of muriatic acid, allowing it to stand for twenty-four hours and filtering. J. Lawrence Smith.

3. *Determination of the amount of Ammonia contained in the Atmosphere;* by A. Graeger, (Archiv. der Pharm., xliv, p. 35, and Chem. Gazet., Jan. 1846, p. 34.)—The method employed by the author, was to pass the atmosphere through muriatic acid contained in a convenient vessel. After thirty-six cubic feet of air had been made to pass through slowly, the acid liquid was evaporated to dryness in a small platinum crucible placed in a water bath, chloride of platinum being previously added. The residue was treated with alcohol and ether, and the insoluble portion collected and weighed. In the above experiment 0·006 grm. of ammonio-chloride of platinum were obtained, and this was found on calculation to correspond to $\frac{3}{5}$ millionth of carbonate of ammonia in the atmosphere. The experiment has been performed in both dry and wet weather with very nearly the same result. J. L. S.

4. *Test for Ruthenium;* by M. Claus, (Chemist, Jan. 1, 1846–7.)—The best means of ascertaining the presence of Ruthenium in the ore of platinum is the following:—Melt it with an excess of nitre in a small platinum spoon, exposing it to a strong heat until the mass no longer swells, but becomes perfectly liquid; then allow it to cool and dissolve it in a small quantity of distilled water. A few drops of nitric acid produce in the orange colored solution, a black precipitate, consisting of ruthenium and potash. If we add hydrochloric acid to the liquid in which the precipitate is found, and heat it in a porcelain capsule, the oxide is dissolved, and by concentration assumes a beautiful orange color. Finally, if we cause sulphuretted hydrogen to pass through the solution until it has become almost black, and then filter it; a liquid of a beautiful sky-blue color will pass through. J. L. S.

5. *Iodine used to distinguish between the Arsenical Antimonial taches formed by Marsh's Apparatus;* by M. Lassaigne, (Comptes Rendus, Dec. 1845, p. 1324.)—The taches formed by Marsh's apparatus are exposed to vapor of iodine, when, if they be arsenical, they become of a pale yellowish brown color, which changes to a lemon yellow, and subsequently disappears by exposure to air or to a gentle heat.

The antimonial taches under the same circumstances, become of a carmelite yellow, which, by exposure to the air, passes to an orange and then they remain unchanged.

The alcoholic solution of iodine dissolves instantaneously the arsenical tache. The antimonial tache is not acted upon immediately by the same solution, although as the solution evaporates, the metallic antimonial tache is replaced by one of an orange red, (the ioduret of antimony.) J. L. S.

6. *On the Decomposition and Analysis of the Compounds of Ammonia and Cyanogen;* by R. Smith, (Phil. Mag., March, 1846, p. 222.)—The ammonia compounds are analyzed by liberating all their nitrogen by means of some of the chlorine compounds, and estimating the amount of ammonia by the gaseous nitrogen. The chloride of lime was the salt usually employed for this purpose. This method is regarded by the author as being peculiarly applicable to the analysis of organic substances. He also proposes the employment of chloride of lime as a ready and accurate method of estimating the quantity of nitrogen contained in urine, from the amount of gas disengaged by its action in the nitrogenous compounds.

Hydrocyanic acid and the cyanides are also very rapidly decomposed by the chloride of lime or soda, yielding nitrogen gas and carbonate of lime or soda. The author has also discovered that the hypochlorites decompose uric acid in a very satisfactory manner, and he is inclined to believe that they may be advantageously used as solvents for uric acid calculi in the bladder. J. L. S.

7. *Preparation of the Hypophosphite of Baryta;* by M. Wartz, (Ann. de Chim. et de Phys., Feb. 1846.)—This salt is prepared by boiling a solution of sulphuret of barium with phosphorus, until gas ceases to be evolved. If the ebullition be continued long enough, the whole of the sulphuret will be decomposed; should this not be the case, it is readily got rid of by the addition of a little carbonate of lead, or by the careful addition of sulphuric acid as long as sulphuretted gas is evolved. If an excess of acid be added, it is easily got rid of by a little carbonate of baryta.

All the other hypophosphites are formed from this by double decomposition with the soluble sulphates. J. L. S.

8. *New Acid in Tobacco;* by M. Barral, (Comptes Rendus, Dec. 1845.)—It has been found that the acidity of water in which tobacco leaves have been steeped, is due to a new acid, called by the discoverer *nicotic acid*, composed of C^3HO^3+HO. J. L. S.

9. *Valerianic Acid and a New Substance from Caseine;* by Prof. Liebig, (Annal. der Chem. und Pharm., Jan. 1846.)—Caseine when fused with its own weight of caustic potash, until hydrogen gas is evolv-

ed along with the ammonia, allowed to cool, dissolved in warm water, and super-saturated with acetic acid, furnishes a crystalline substance that is but slightly soluble in cold water and insoluble in alcohol and ether. Its composition is $C^{16}NH^{9}O^{5}$. It is soluble in the alkalies, and combines with acids. If the fused caseine and potash be treated with tartaric instead of acetic acid, and the liquid submitted to distillation, it furnishes valerianic acid. This acid appears to be preceded in its formation by *leucine*, which substance is itself converted in to valerianic acid by the action of potash. J. L. S.

10. *Bromo-boracic Acid*, (*Bromide of Boron;*) by M. Poggiale, (Comptes Rendus, Jan. 1846.)—It is prepared by passing the vapor of bromine through a mixture of charcoal and boracic acid, heated to redness in a porcelain tube. It is well to heat the mixture of charcoal and boracic acid for about half an hour previous to passing the vapor of bromine through it, in order to get rid of any moisture. The acid, which is a gas, can be collected over mercury, this metal absorbing any excess of bromine. It is a colorless gas with a pungent odor and acid taste ; it extinguishes combustion and affords white vapors in contact with the air. Chlorine decomposes it with the liberation of bromine. Its density is 8·6443, and its composition is BBr^{3}. J. L. S.

11. *Quantitative estimation of Bromine in Mineral Waters;* by M. Heine, (Journ. für Prakt. Chem., xxxvi, 181, and Chem. Gazet., March, 1846, p. 103.)—A series of liquids containing a known amount of bromine is prepared, by dissolving in every ounce of distilled water from five to fifty milligrammes of bromide of potassium, making a series of ten liquids. Equal quantities of ether, measured in the same glass, are added to these different solutions and the tubes immediately closed. An equal quantity of chlorine water is next added to the solutions and the mixture well shaken. Upon allowing it to rest, the ether collects on the surface, holding in solution the bromine, and we thus obtain a regular scale of colors, from yellow to brown, and these solutions now serve as standards of comparison. Beyond fifty the comparision becomes more uncertain, because the tints of every additional five milligrammes of bromide of potassium can no longer be well distinguished, on account of the dark color. Five milligrammes of bromide of potassium is equal to 3·3 milligrammes of bromide.

As soon as the scale of colors has been prepared, an ounce of the liquid to be examined, is introduced into a vessel similar to the ones containing the test solutions, and to it is added the same amount of chlorine and ether as in the other cases, it is shaken, and the ether allowed to collect upon the surface, the color of which, by comparison with the scale colors, will indicate the amount of bromine present. J. L. S.

12. *Solubility of Sulphate of Lime;* by M. Anthon, (Chem. Gaz., May 1, p. 173, from Buch. Report, xli, 363.)—M. Anthon digested pure artificially prepared gypsum, at the ordinary temperature, in a close vessel with distilled water, and in another with a saturated solution of common salt. On examination he obtained from 1000 grains of the *first* liquid with chloride of barium, 3·1 grains, and from the *second*, 11·1 grains, sulphate of baryta. In accordance with this, gypsum dissolves in 438 parts pure water, and in 122 parts solution of chloride of sodium.

13. *Analyses of Glass;* by M. Peligot, (L'Institut, No. 638, March 28, 1846.)—Bohemian fine glass—silica 76, potash 15, lime 8, alumina 1.

Bohemian agate glass—silica 80·9, potash 17·6, alumina 8, traces of oxyd of iron 0·8, lime 0·7.

Artificial aventurine from the works at Murano and Venice—silica 67·7, lime 8·9, sesquoxide of iron 3·5, oxyd of tin 2·3, metallic copper 3·9, oxyd of lead 1·1, potash, soda 12·6, with traces of alumina, magnesia, and phosphoric or boracic acid. From this analysis it appears that this aventurine differs widely from the glass made in imitation of it by MM. Frémy and Clémandot.*

14. *On the Solubility of Fluoride of Calcium in water, and its Relation to the occurrence of Fluorine in Minerals, and in Recent and Fossil Plants and Animals*; by George Wilson, M. D., F.R.S.E., (Chem. Gaz. May 1. 1846, p. 183—read before Roy. Soc. Edinb.)—After a preliminary reference to the existence of fluorine in recent and fossil bones, Dr. Wilson stated that he had made a series of experiments with a view to discover what solvent carried fluoride of calcium into the tissues of plants and animals.

His first trials were made with carbonic acid, which was passed in a current through water containing pure fluor-spar in fine powder suspended in it. The fluor-spar was, by this treatment, dissolved, yielding a solution which precipitated oxalate of ammonia, and when evaporated left a residue, which on being treated with sulphuric acid gave off hydrofluoric acid. The author was inclined, in consequence, to suppose that carbonic acid conferred upon water the power of dissolving fluoride of calcium; but on observing that, long after the whole of that gas had been expelled by warming the liquid, the latter remained untroubled, he became satisfied that water alone can dissolve fluoride of calcium, contrary to the universal statement of writers on chemistry.

On prosecuting the inquiry, he found that water at 212° dissolved more of the fluor-spar than water at 60°; but he has not yet ascertained the proportion taken up by that liquid at either temperature.

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* See this Journal, Second Series, i, 430.

The aqueous solution of fluoride of calcium was found to give with salts of baryta a precipitate, which required a large addition of hydrochloric and nitric acid to dissolve it.

The author pointed out the difficulty which must in consequence occur in distinguishing between fluorides and sulphates, and suggested that fluorides may have been mistaken for sulphates in the analysis of mineral waters. He referred also to the objection which must now lie against the present method of determining the quantity of fluorine present in bodies, consisting as it does in converting that element into fluoride of calcium, which, in the course of the necessary analytical operations, is washed freely, and must be seriously diminished in quantity; a fact which has of necessity been hitherto overlooked.

Dr. Wilson stated, that he was not yet able to suggest an unexceptionable quantitative process; but that, at all events, the fluoride of barium, being much less soluble than the fluoride of calcium, might in the meanwhile be substituted for it in the examination of fluoride.

The author then proceeded to state, that, in consequence of the observation he had made as to the solubility of fluoride of calcium in water, he had been led to look for that body in natural waters, and had found it in one of the wells of Edinburgh, viz. in that supplying the brewery of Mr. Campbell, in the Cowgate, behind Minto House. At the same time he stated, that preceding observers had already found it in other waters. He believed however, that he was the first to detect it in sea water, where, by using the *bittern* or mother-liquor of the salt-pans in which water from the Frith of Forth is evaporated, he had found it present in most notable quantity. The author referred to the presence of fluorine in sea water, as adding another link to the chain of observed analogy between that body and chlorine, iodine and bromine.

Dr. Wilson further stated, that he had confirmed the observations of Will as to the presence of fluorine in plants: and Berzelius's discovery, that fluorine exists in the secretion from the kidneys; and had, in addition, detected fluorine in milk and blood, in neither of which has it hitherto been suspected to occur. The paper concluded by some observations on the presence of fluorine in fossils, and its relation to animal life.

15. *Remarkable Discoveries in Isomorphism;* by M. Scheerer, (in a letter to B. Silliman, Jr., from Berzelius, dated March 10, 1846.)—Mr. Scheerer has just found that in compounds containing magnesia, protoxide of iron, oxide of nickel and other oxides isomorphous with magnesia, a part of the base may be wanting without a change of crystalline form, provided that this part be replaced by a quantity of water which contains three times as much oxygen as this part of the base. For example, the compounds $\dot{Mg}^3\dddot{Si}$, $\dot{Mg}^2\dddot{Si}+3\dot{\mathbf{H}}$, and

$\dot{\mathrm{Mg}}\dddot{\mathrm{Si}}+6\dot{\mathrm{H}}$ in accordance with this principle, are isomorphous. Thus *chrysolite and serpentine may be isomorphous.* The composition of the first, $\dot{\mathrm{Mg}}^3\dddot{\mathrm{Si}}$, is anhydrous and constant. Serpentine is hydrated and has a varying composition, wherever found, not affording a chemical formula. But examined with reference to M. Scheerer's views, we observe that in all the best analyses of serpentine, the oxygen of the magnesia and of the protoxide of iron, added to *one third* the oxygen of the water, is equal to that of the silica; and consequently serpentine is a variable mixture of two isomorphous silicates, $\dot{\mathrm{Mg}}^3\dddot{\mathrm{Si}}$, and $\dot{\mathrm{Mg}}^2\dddot{\mathrm{Si}}+3\dot{\mathrm{H}}$. M. Scheerer has brought forward numerous other examples from among silicates, sulphates, &c.

M. Scheerer has also discovered that oxide of copper may be replaced in an isomorphous manner by *two* atoms of water.

We may now see clearly why so many hydrated minerals have never given uniform results, even with the most careful analyses.

The memoir of Scheerer will appear in two or three months, in Poggendorff's Annalen at Berlin. The facts here briefly stated were communicated by him to the Academy of Sciences at Stockholm, at its last session.

16. *Influence of Magnetism on Crystallization;* by R. HUNT, (Phil. Mag., Jan. 1846, p. 1.)—It has been supposed by many writers that electric or magnetic currents must have an influence on the position and character of forming crystals. The experiments of Mr. Hunt illustrate and establish this point in an interesting and satisfactory manner.

A tube containing a concentrated solution of nitrate of silver, was placed against the poles of a permanent horse-shoe magnet, and another tube was set away by itself. Crystallization commenced first in the former, and the crystals started at different angles from the glass where it was in contact with the magnet; none forming above the magnet. In the other tube the crystals had no regular arrangement.

In a second and third experiment, by using for comparison another metal, he shows that the *cooling* influence of the metal was not the cause of this arrangement of the crystals. The crystals, when both poles of the magnet were placed against a capsule containing the same salt in solution, and a piece of metal not magnetic on the opposite side, formed in the fluid almost wholly adjoining the north pole; only three long crystals appeared opposite the south pole, and these were directed towards those springing from the north pole. The same result was obtained in four repetitions of the experiment.

A steel needle was attached, one, to each pole of a suspended magnet, and the two were made to dip into a solution of nitrate of silver in a watch glass. The crystallizing pellicle on the surface, exhibited curved lines as represented in fig. 1, which lines it is observed are strikingly similar to those assumed by iron filings sprinkled on a paper which is placed over a magnet.

Wires similarly arranged were dipped into sulphate of iron; crystallization commenced around the north pole, and soon after around the south. The position of the crystals showed an obvious tendency to conform to lines of magnetic direction.

When protronitrate of mercury was exposed to the same action, crystallization began at the north pole, and proceeded rapidly to a line half way between the two wires, one half of the fluid being crystallized and the other remaining fluid. At length a few crystals formed around the south pole wire, taking a direction towards those of the north pole.

Fig. 1.

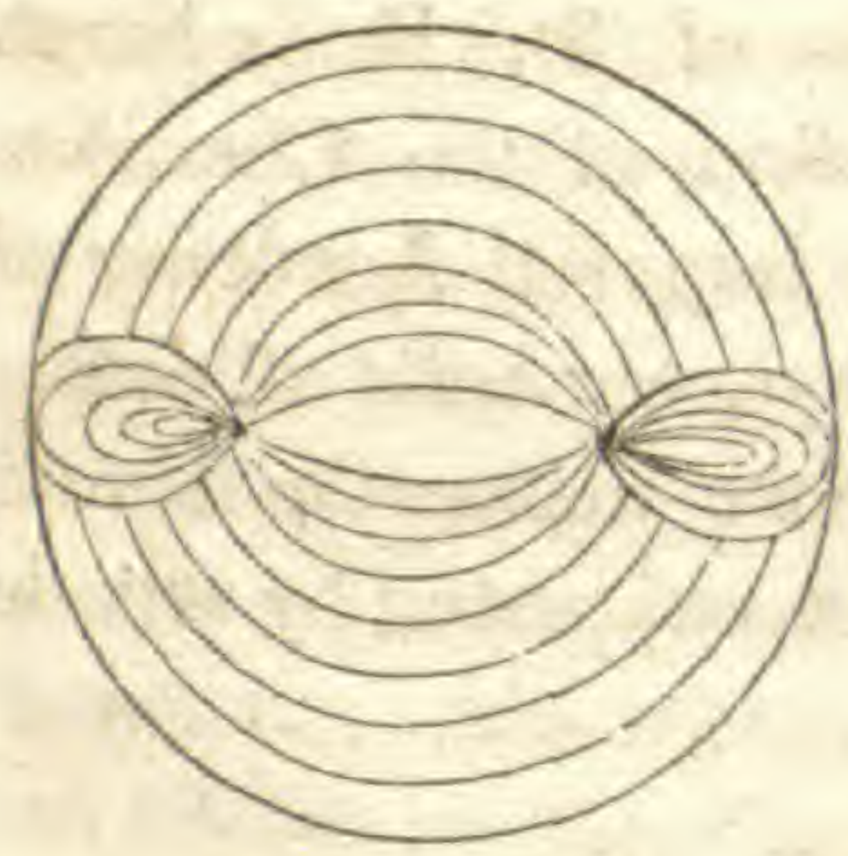

Fig. 2.

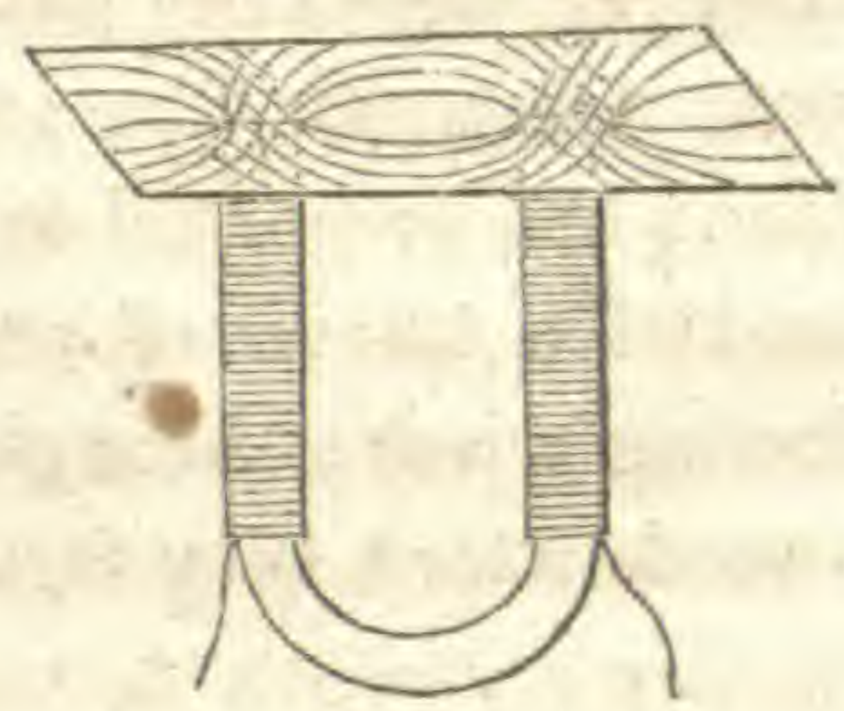

Fig. 3.

Crystallization of nitrate of mercury on a plate of glass over an electro-magnet capable of holding fifty pounds, had the arrangement of lines in figure 2 annexed: and with a small battery of more permanent but less powerful arrangement, the result in figure 3 was obtained.

When a plate of copper was substituted for the glass, and a weak solution of nitrate of silver employed, the curves in figure 4 were produced.

Fig. 4.

Fig. 5.

Fig. 6.

A tolerably strong solution of nitrate of silver was put on the copper plate, and this left in contact with the magnet for a night, when the copper was bitten deeply by the acid of the salt of silver, in the oval form in figure 5, the inner part of the oval remaining bright.

Figure 6 illustrates another curious result obtained on a glass plate from a weak solution of nitrate of silver and an equally weak solution of sulphate of iron; in five minutes the silver was precipitated in curves as in figure 4, and shortly two curious curved spaces were formed by the fine deposit proceeding from one pole towards the opposite, increasing in width and then abruptly ceasing before reaching the other pole.

17. *Faraday's View of Luminiferous Ether;* (Athenæum, No. 965.)—Prof. Faraday, at the meeting of the Royal Institute in April, remarked that the conclusions of Dr. Lyon Playfair, so like his own, and the consideration of the like velocities of light through space and of electricity through dense matter, induced him to utter a speculation long on his mind, and constantly gaining strength: viz., that perhaps those *vibrations* by which radiant agencies, such as light, heat, actinic influence, &c., convey their force through space, are not vibrations of an ether, but *vibrations of the lines of force, which, in his view, equally connect the most distant masses together*, and make the smallest atoms or particles by their properties influential on each other and perceptible to us.

18. *Electrophonic Telegraph.*—The journals of St. Petersburgh speak of an electrophonic telegraph, the invention of the Chevalier Lasckott, which Prof. Jacob has presented to the Imperial Academy of that city. It is composed of a clavier of ten keys, ten bells of different sizes, and ten conducting wires; through whose means the letters of the alphabet and the words which they form are expressed by sounds and harmonies.

II. Mineralogy and Geology.

1. *Ores and Minerals of Lake Superior;* by C. T. Jackson, (Bost. Nat. Hist. Soc. Proceed., March, 1846.)—In connection with many valuable details respecting the mines of Lake Superior, Dr. Jackson states several facts of mineralogical interest. Some of the large masses of pure copper obtained, are stated to be covered with crystals of copper of octahedral and dodecahedral forms. On exploring the chrysocolla deposit at Copper Harbor, a remarkable vein of black oxyd of copper, with black and brown silicates, was discovered. The vein is from eight inches to a foot wide where the black oxyd is obtained, but is very irregular. Dr. Jackson suggests that the chrysocolla, or hydrous silicate of copper, was originally a gelatinous mass, like silica, and that it was deposited on the cooling of the rock; while in the more heated interior the black and brown anhydrous silicates were deposited. He also suggests that the black oxyd might have been precipitated from the hot siliceous solution by the action of hot lime water, which was evidently abundant, and adds that this operation may be easily imitated in the laboratory of the chemist. Trap rocks occur near the vein, and to them the heat is attributed; and the alkalies which produce the analcime in place of laumonite, may have originated from the subjacent igneous rock. Laumonite also occurs in this and in an adjacent calca-

reous spar vein, and is doubtless derived from the lime of the spar and the siliceous and aluminous ingredients of the conglomerate and sandstone. Datholite and prehnite in many of the veins contain points of metallic copper; and this fact is supposed to prove a rapid production of these minerals, instead of slow infiltration, on the ground that if it had been slow, the copper would have been oxydated.

2. *Damourite in the United States;* by E. Teschemacher, (Bost. Nat. Hist. Proceedings, p. 107, March, 1846.)—Damourite, according to Mr. Teschemacher, occurs among the minerals of Chesterfield, Mass., and also with the kyanite of Leiperville, Penn. It is met with as a yellow amorphous incrustation. It gives off water before the blowpipe, becomes milk-white, and melts in the strongest heat at the edges to a white enamel.

3. *Diamonds in North Carolina.*—We have seen a beautiful diamond of fine water, weighing about four grains, taken from a gold washing in Rutherford county, N. C., and understand that others have been found in the same state.

4. *Martinsite, a new Mineral;* by M. Karsten, (L'Institut, No. 638, March 25, p. 101.)—The name Martinsite, in honor of Capt. Martin of Halle, has been given to a saline mineral from the salines of Stassfurth, composed essentially of 9·02 parts of sulphate of magnesia, and 90·98 of chloride of sodium. This corresponds to 10 parts by weight of common salt to 1 of sulphate of magnesia.

5. *Transparent Anadalusites from Brazil;* by M. Haidinger, (Bull. Soc. Geol. de Franu, 2d ser., i, 20.)—These crystals are green when viewed perpendicular to the faces, and hyacinth-red viewed parallel with the line which unites the longer basal edges.

6. *Diamonds of the Ural;* (Murchison's Russia.)—Mr. Murchison states that he saw upwards of forty specimens of diamonds, in the cabinet of Prince Butera, which were detected in the detritus upon the banks of the Adolfski rivulet, when the alluvium was there worked for gold. The workings for gold having been discontinued in this place, no more diamonds have been found. Baron Humboldt, before his visit to Siberia, had foretold that diamonds would be found in the Ural, as they had in other countries which contain platinum and palladium; while he was there the discovery at Chrestovodsvisgensk was made, and since then they have been found at three other places in the Ural chain. A quartzose micaceous shist, identical with the *itacolumite* of the Brazils, occurs in a portion of the chain adjacent to those mines where the diamonds have been found, as well as in other parts of the Ural. A Brazilian specimen of itacolumite in the Imperial museum of the school of mines contains two diamonds. M. Claussen says that in the province of Mina's Geraes, (Brazil,) powerful and slightly inclined beds of soft

micaceous sandstone having the aspect of itacolumite, repose directly on transition rocks, and contain diamonds between the flakes of mica, just as garnets occur in mica shist.* Mr. Murchison concludes that these precious stones were originally formed in different parts of the world, in secondary deposits not more ancient than those which constitute the flanks of the Ural chain.

7. *Minerals of the Miask;* (Murchison's Russia, 437.)—Mr. Murchison informs us that the rich mineralogical treasures from the Miask region in the Urals, and described by M. G. Rose in his work on the Uralian minerals, are all found either in beds, veins, or nests of the granitic ridge of the Ilmen. Some of these are, zircon, black mica in large plates, green feldspar in enormous crystals, albite, elæolite, sodalite, cancrinite, apatite, ilmenite, pyrochlore, monazite, hornblende, beryl, topaz, garnet, &c. Masses of the rock with which some of the above minerals were associated, and which dip south-west from the sides of the greater Ilmen, and appeared to be nothing more than flag-like stratified granite, forming the external coating of the hill, have, under the critical examination of M. Rose, been distinguished by the new name of "Miascite"—a rock in which in addition to white feldspar and black mica, the place of quartz is taken by elælite. All these rocks are considered as of plutonic origin. On the eastern flank of the Ural-taw, chromate of iron is abundantly found, not less than 20,000 poods† being transported annually to Moscow from one spot, dependent on the Polakofsk Zavod. There, as elsewhere, its associates are serpentine and magnetic iron.

8. *Huge mass of green Malachite;* (Ib.)—At the copper ground of Nijny Tagilsk, at the chief Zavod of the Demidoff family, a mass of green carbonate of copper has lately been disclosed, of unparalleled size. It occurs at a depth of 280 feet, and its base had not been found at the time of Mr. Murchison's visit, only a part of its summit and sides had been cleared from the matrix. The summit alone has a width of about 9 feet and a length of about 18 feet, an enormous botryoidal mass being exposed beneath. The whole of the surface which had been exposed, was calculated to contain upwards of half a million pounds of pure and solid malachite.

9. *Gold and Platina of the Ural and Siberia;* (Mr. Murchison's Russia and the Ural.)—The available deposits of the precious metals in Russia are all of them diluvial sands and coarse gravel, and these are found only on the eastern slope, or Asiatic flank of the Ural mountains, and the comparatively level portions of *eastern* Siberia. The geological

* Bulletin de l'Acad. de Bruxelles, 1841, tome viii, p. 330.

† A pood is about 36 lbs. English.

age of these deposits and of the gold veins is of comparatively recent date and little, if at all anterior to the destruction of the mammoths.

Mr. Murchison concludes that what we now call the Ural mountains, constituted, at the period of the formation of the cupriferous gravel now found on the Permian plains, (west of the Ural,) the rocky shore of a very ancient and probably low continent, from which powerful streams descended into a western sea. From the entire absence of gold in all the deposits there found, and in the earlier "reliquiæ" of this chain, as the carboniferous conglomerates, he infers, with inductive certainty, that this old continent afforded no gold; for had it been so, some trace, however slight, of gold or platinum must have been found in the Permian debris; and yet the long and patient workings of the detrital copper mines on the European side of the chain have never disclosed such a thing. From these and other data, he concludes that the chain became auriferous during the most recent disturbances, by which it was affected, and after the highest peaks were thrown up, when the present water shed was established, and when the syenitic granites and other comparatively recent igneous rocks were erupted along its eastern slopes.

"The only detritus in which grains and portions of gold and platinum have been found, is that in which remains of mammoths and rhinoceroses have also been detected, and coupling this fact with the omission of all auriferous veins in the more ancient alluvia of the chain, there can be no doubt that in this region, gold was one of the most recent mineral productions anterior to the historic era." "We believe, then, that before the surface assumed its present outline, the tract we now call the Ural mountains was a low ridge, extending from north to south, and forming the western shore of a continent on which such animals lived and died during long ages." (475.)

The gold detritus of the Ural is not the residue of rivers and streamlets, but is a coarse gravel and shingle, composed chiefly of moderately sized and small subangular fragments of the adjacent rocks. The sides of the Ural are devoid of those great transported, and rounded blocks, which cover the Scandinavian and other chains; every loose fragment having been derived from an adjacent elevation, and washed down in strict relation to the chief existing features of the land. The term *drift* cannot be correctly applied to the Uralian masses, which are purely *local;* neither do the sides of the mountains exhibit striæ of denudation, nor polished surfaces.

The gold mines of Ekaterinburg are interesting as offering the only subterranean shafts in all this region, by which gold is still extracted from the parent rock. The mines have furnished from 1745 to 1841, 52,000,000 poods of ore stuff, (about 940,000 tons of 2,000 lbs.) and this had yielded 679 poods of gold, or about 2,445 lbs. The gold here occurs in quartz veins, which are contained in parallel bands of a felspathic rock, called "beresite," which Rose considers as a decomposed granite, trending from north to south. The chief fundamental rocks are talcose and chloritic schists and clay slates, and through these the "beresite" cuts. The shafts, none of which are lower than 25 fathoms, are sunk vertically, and lateral galleries are made in the masses of "beresite," which in contact with the quartz veins is usually compact and hard, but at a little distance from them it resembles kaolin or decomposed feldspar rock. Between the beds and the "beresite," the talcose rock is changed into a reddish and decomposing altered rock, called "*crassick*" by the workmen.

The auriferous alluvium invariably overlies the auriferous rocks, "beresite," and other granitic rocks, clay slate, and loose limestone, which are often of great extent, but so poor in gold as not to pay for working, all the productive mines being in the alluvium. The alluvium is notably rich along the zone, where greenstones, porphyries and serpentines have traversed ancient limestones, and is most productive in those spots where the broken materials and coarse sands are most ferruginous. During the progress of washing, the black glancing grains of magnetic iron ore form a good indication of the presence of gold. The annexed diagram will show the relations here explained.

The auriferous rocks are seen *in situ* at (*a*.) The auriferous detritus immediately over them (*b*,) covered by the overlying clay (*c*,) capped by humus and bog. The small stream called the Berezof (*d*,) cuts through this gravel, and by its aid the workings are accomplished. The bones of mammoths and other extinct quadrupeds are also found in these auriferous gravel beds.

The mine of Peshanka, near Bogoslofsk, is in a sandy gravel, containing no fragments of quartz veins, and it is supposed that the gold was here also uniformly diffused in the subjacent syenitic rock, which is said to yield gold on analysis. From 1829, when it was discovered, to 1840, or in eleven years, this mine yielded 256 poods, or 10,000 Russian pounds of gold.* The gold alluvium is always a coarse local detritus, varying from 2 to 10 or 12 feet in thickness, and usually covered with much stiff clay. The stony fragments of course vary in every locality with the nature of the adjacent rocks, but quartz

* The Russian pound is 14 oz. 7 dr. English.

abounds in nearly all. In one set of works, fragments of "beresite" prevail, in another greenstone porphyry, in a third serpentine, in a fourth augite porphyry. Iron pyrites appears in one and not in another; but garnets, zircons, magnetic iron ore, chromate of iron, specular and other ores of iron are with rare exceptions common to all these accumulations. The gold mines south of Miask, are among the most productive of the Russian mines, in the undulating grounds on the western side of the Miask. This rich detritus has been carried by the diluvial current quite to the summit of some of the greenstone hills. In the depressions the greatest masses of detritus have accumulated, and are there covered with a thick spread of clay. In these hollows, particularly around the Zavod of Zarevo Alexandrofsk, the very heavy pepites or lumps of solid gold have been found. These masses have weighed respectively 13, 14 and 24 pounds, but since Mr. Murchison's visit, the huge lump weighing 78 English pounds has been found; all of these are in the Imperial museum at St. Petersburg. As a general thing, however, large lumps of gold are an exception in the Ural.

Platinum, in the Urals, is now worked only within the territories of the Demidoff family. Mr. Rose found gold in only one of the numerous platinum deposits which he examined, and in no instance could he detect any vein-stones of quartz or other fragments of rocks, or of magnetic iron, so abundant in the gold alluvia. It has been found in grains weighing from 14 oz. to 1 lb. and rarely 2 and 3, and in one instance 8 lbs. It is found in much smaller accumulations than the gold, but like the gold, it has been lately shown by M. Schwetzof and M. Le Play, that it is disseminated throughout the entire mass of certain crystalline rocks. He has traced up more than 20 courses of platiniferous alluvium to the common centre, the Mount La Martiane, from which they have been all derived, and of whose detritus they are all composed. This cannot, however, be taken as a general fact of the origin of this metal.

10. *Axinite and other Minerals in a Fossiliferous rock;* by M. A. Daubrée, (Bull. Soc. Geol., 2d. ser., i, 408.)—Axinite has been detected in the Vosges in a fossiliferous rock, which had been altered by contact with a variety of trap. The rock had been rendered hard siliceous, and had lost its fissile character. It contains numerous impressions of Calamopora spongites (Goldfuss,) and Flustras; and in these same parts, there are nodules of lamellar calcite, and also some epidote, hornblende and quartz. It appears that the lime of these nodules was derived from corals, and the same contributed to the formation of the epidote and hornblende. Moreover, the crystallization of these minerals took place without a softening of the rock. In some cavities there are crystals of these minerals with others of Axinite.

11. *Fluoride of Calcium in Cannel Coal*; by H. D. ROGERS, (Proceed. Bost. Nat. Hist. Soc. p. 109, March, 1846.)—Prof. Rogers remarks that the English Cannel coal, which he had been using in his grate, often dispersed over his apartment, with a violent crepitation, small fragments of fluor spar. Some of the fragments were more than half an inch in diameter. Afterwards, upon breaking a piece of the coal, he detected a small isolated crystal of this mineral. Prof. Rogers suggests that the elements of this mineral may have been derived from the coal vegetation; adding also, that it is possibly due to volcanic agency below, setting at liberty vapors of hydrofluoric acid.

12. *Petrified Wood in Texas;* by J. LIMBER, (in a letter dated, Independence, Texas, April 24, 1846.)—In this region, and especially north of this, pieces of wood, petrified, are found in great quantities. In some localities, stumps of trees three feet through, pieces of trunks of trees of the same size, and from two or three to twenty feet long, cover the whole face of the ground. Magnificent specimens might be obtained for cabinets. Should any institution wish a specimen, and will write to me, I will take a pleasure in procuring for them, specimens of such size as they will specify. The expense of transportation would not be great, as they could be taken down the Brassos to the Gulf of Mexico, and thence to any part of the United States by water.

13. *Falkland Islands;* by C. DARWIN, (Athenæum, No. 965.)—The low lands of the Falkland Islands consist of clay slate, containing subordinate layers of sandstone, and the slate occasionally, though rarely, and the sandstone more commonly, give indication of fossils, which prove the existence of palæozoic rocks in these southern regions. The exact position among palæozoic strata is not determined. The slaty and fossiliferous beds of these islands are broken by numerous east and west ranges of stratified quartz, attaining sometimes a height of 2,500 feet.

14. *Tertiary of Warren Co., Mississippi;* by T. A. CONRAD. (Communicated for this Journal.)—While collecting the organic remains of Warren county, Mississippi, I noticed a few shells which appeared to be identical with species from Claiborne, Alabama, but since I have carefully compared them in my cabinet, they prove to be distinct; and it is very remarkable that of the one hundred and three species of fossils found near Vicksburg, not one can be identified with a species of the Eocene of Maryland, Virginia, or Alabama. There is a species of Trochus resembling T. agglutinans; but the specimen is too imperfect to decide whether it agrees with the fossil T. agglutinans of Georgia. The Vicksburg group has decidedly more affinity with the Eocene group than with that of the Miocene, for there is only one species that closely resembles a Miocene fossil. The limestone of Clarke

county, Ala., and of St. Stephens on the Tombeckbee, contains Nummulites crustaloides and Pecten Poulsoni, (Morton,) two fossils which abound in the Vicksburg deposits, and this limestone is therefore probably of the same age as the tertiary beds of Vicksburg. This formation marks a distinct era in the American tertiary system, intermediate to the Eocene and Miocene formations, but more nearly allied to the former, and perhaps it will be proper to class it as a subdivision of the Eocene. The following table will explain these subdivisions.

Miocene,	Maryland, Virginia, &c.	About 50 recent species.
Upper or newer Eocene,	Natchez, Vicksburg, &c.	103 extinct species; no recent species; and all distinct from those of the lower division.
Lower or older Eocene,	Piscataway, and Fort Washington, Maryland, Claiborne, Alabama, &c.	200 extinct species.

The following genera of shells occur at Vicksburg.

Univalves.		*Univalves.*		*Bivalves.*		*Bivalves.*	
	No. of species.		No. of species.		No. of species.		No of species.
Actæon,	1	Oliva,	2	Astarte,	1	Mytilus,	1
Buccinum,	2	Pyrula,	2	Amphidesma,	1	Nucula,	3
Bulla,	1	Purpura,	1	Avicula,	1	Ostrea,	1
Cypræa,	2	Pleurotoma,	7	Arca,	1	Panopea,	1
Cancellaria,	1	Rostellaria,	1	Cardium,	4	Pecten,	1
Carsis,	6	Solarium,	2	Chama,	1	Pectunculus,	1
Dentalium,	1	Scalaria,	1	Crassatella,	1	Pinna,	1
Fusus,	2	Sigaretus,	2	Cytherea,	4	Sanguinolaria,	1
New Genus,	1	Turbinella,	2	Corbula,	3	Tellina,	3
Mitra,	6	Triton,	3	Capsa,	2	Venus,	2
Murex,	1	Terebra,	1	Lucina,	1	*Multivalves.*	
Natica,	3	Typhis,	1	Loripes,	1	Pholas,	1
Nummulites,	1	Turritella,	2	Lima,	1	Balanus,	1

A few of these fossil shells have a striking resemblance to species from Dax, Grignon and Bordeaux, and I believe that the Vicksburg tertiary will prove to have been deposited in an era more nearly allied in age to that of the localities mentioned above, than to the Eocene of Paris or London.

III. Zoology.

1. *On the Zeuglodon Remains of Alabama;* by S. B. Buckley. (Communicated.)—Since it has been conclusively proved that the bones of the Zeuglodon, which Mr. Koch exhibited in New York and elsewhere, under the name of Hydrarchos, belonged to different individuals, some may be disposed to doubt that the skeleton of the Zeuglodon, which I obtained in Alabama, now in possession of Prof. Emmons, at Albany, N. Y., is of one individual animal. On this point I would make the following statements.

Through the assistance of Judge Creagh, of Clark Co., Alabama, at a locality nearly three miles from his house, (I think southeast) I obtained a vertebral column fifty feet in length, commencing near the tail and extending towards the head. Judge Creagh had commenced digging at the same place about three years before and found some twenty or twenty-five feet in length of the vertebral column. These vertebræ at the locality extended in a line in their natural order, but owing to their exposed situation the processes were mostly broken off. After considerable search we struck the remaining portion of the vertebræ, at a depth of about two feet, and traced them to a depth of six feet, extending into a side hill. Up to this point the vertebræ lay in close connection, joining end to end, but here their connection was broken off, and owing to the difficulty of digging we ceased work, despairing of obtaining the remainder, which could probably have been secured at the expense of much time and labor. The tail of this individual lay imbedded in a rich bottom composed of black vegetable mould, and its head, without doubt, lay beneath the adjoining hill. The black soil was about eighteen inches deep; beneath this was a yellowish white marl to the depth of six feet, below which was a hard green sand marl in which the last bones we obtained at this locality were imbedded. These bones were numbered, and left in Judge Creagh's door-yard at his request, for the state collection of Alabama; as to their fate since, I have not been informed.

After a few months I returned to Judge Creagh's in 1842, who informed me that a few years before, he had got a few bones to send to Harlan, at Philadelphia, at a locality about three miles distant, and not far from the place where we obtained those already mentioned. We went there chiefly to obtain a head or parts of one; and at a depth of from one to three feet, we dug out a vertebral column commencing near the lumbar region and extending towards the head, measuring twenty six feet in length. The vertebræ were often displaced, sometimes one, two and three feet intervening between them, among which were scattered ribs which were *in situ*, and were generally broken in the middle, the two opposite ends approaching each other. By carefully removing the earth from the upper surface of several of these, we found their length from measurement taken on the spot, to be from four to six feet. At the time we were digging, the ground was very wet from recent rains, and the ribs were so brittle that we succeeded in getting only a few fragments, not more than two or three of which are now with the skeleton at Albany. The vertebræ at this locality were large and in an excellent state of preservation, better than those I found at any other locality, and I now regret that I did not bring any of them away, since they were all left on the ground. While I was engaged here with one of Judge C.'s negroes, a servant came with the following letter from Judge C., the original of which is now in my possession.

"*Dear Sir*—Most fortunately and apropos, this morning a negro fellow discovered twenty-five feet of a Basilosaurus, with the head, &c., in a line exposed upon the surface of the earth. From appearances, the balance can easily be obtained. I send a boy with a horse for you, supposing it best for you to return to the bones and commence operations here. The place is about half a mile from the house.

Yours respectfully, J. G. CREAGH."

On the receipt of this I repaired to the spot, where I saw for the first time parts of a head and teeth of the Zeuglodon. The Judge had not suffered any of the vertebræ to be disturbed, merely having caused a thin layer of earth to be removed, so as to expose twenty five feet of the animal. A negro that morning had discovered them with his plough, while ploughing, lying in a gentle slope of land, whose surface had been much carried away by the late rains. The field had been in cultivation during many years. Here we obtained the skeleton, which is now at Albany, of which I gave a short account in this Journal in the spring of 1843, and I now repeat what I then published, that it evidently and undoubtedly belonged to one individual animal; excepting the vertebræ of the neck, which were partly displaced, (but lay on a surface less than a rod square, and those that were displaced lay near the head or rather its fragments,) the vertebræ were in an almost unbroken series to the extreme tail—most of them were connected and sometimes two or three would stick together when pryed out of their bed, their ends generally joined; nor do I think there was more than once a vacancy of six inches. The vertebræ increased in size from the neck downward, attaining their maximum size in the lumbar region, at which point our skeleton attained a length of sixty feet or more, and we were much disappointed when it tapered off soon to the tail, at a length of nearly seventy feet. The general outline of the skeleton greatly resembles that of the Plesiosaurus, and this lead Judge Creagh and myself at the time in our discussions with regard to the nature of the animal, to say that Owen must be wrong in referring it to the Cetacea.

These bones constitute by far the most perfect skeleton of the Zeuglodon known, and they are now in possession of Prof. Emmons, at Albany, N. Y. The vertebræ are numbered in the order in which they were obtained.* The boxes in which the bones were brought from

* Our skeleton has the anterior terminal portions of both jaws, with teeth, base of lower jaw, a perfect femur, a portion of a scapula, with the heads of the humerus, an entire humerus, a distinct portion of a fore arm, radius and ulna, a portion of a pelvis, with many fragments of ribs from one to three feet long, besides the vertebræ already named.

Alabama contained a few portions belonging to other individuals, among which are one or two vertebræ which were not numbered, and which were never intended to be palmed off as belonging to the skeleton. Also a few fragments of ribs already mentioned, and the tibia (?) figured by Prof. Emmons, and described in the American Quarterly Journal of Agriculture and Science, vol. iii, p. 227. This specimen belongs to the first individual described in this note. However, no one would suppose but that it belonged to the skeleton at Albany, since the vertebral columns of the two individuals were nearly of the same size. The base of the lower jaw, plate 1, fig. 1., described by Dr. Emmons, p. 228 of the same volume, was obtained near the summit of the hard grey limestone bluff, about a mile from Suggsville, Clark Co., and about twenty-five miles distant from the Creagh plantation. This bone was imbedded upon the upper surface of the rock, and the outer surface of the bone was exposed and showed the yoked teeth with their large serratures in great perfection. It was upwards of three feet long. Owing to the hardness of the rock and brittleness of the bone, the specimen was often broken before detaching it with a large portion of rock, at the close of a toilsome day's work. I obtained this specimen through the kindness of Dr. Denny, of Suggsville, who informed me of its existence. It is proper to add that the skeleton at Albany has its own portions of the lower jaw, so that Prof. Emmons knew that it belonged to a different individual, and has merely described it as an interesting bone of the collection.

I should have stated that before going to Suggsville I visited another locality about a mile from Clarksville, on the road towards Macon, in Clark Co. This skeleton was in a sandy loam, and the bones were in a bad state of preservation, doubtless caused by the predominance of sand and deficiency of lime in the soil. I only staid there part of a day, having met with several thin plates of bone belonging to the jaws, several cervical vertebræ and fragments of ribs. The vertebræ and ribs were larger than those of the skeleton at Albany, and were all left on the spot excepting two fragments of ribs eight or ten inches long, which are with the skeleton at Albany. My object in visiting this locality was to obtain something approximating to a perfect head, and as soon as I saw it could not be done, the locality was abandoned. I believe that a larger vertebral column than any yet obtained is still there. I saw a single vertebra of the zeuglodon, in possession of Mr. Cooper, a lawyer at Claiborne, which was eighteen inches long, and twelve inches in diameter at the ends.

From what I have written it will be seen that the bones which I have enumerated as not belonging to the individual skeleton in Albany, add not to its size, nor were they ever intended by me to be considered as part of that skeleton; but only more fully to illustrate the nature of the remarkable animal to which they belonged. I will add, that Judge Creagh informed me that the bones which he sent to Harlan, were found in different and distant places on his plantation, but described by Harlan as from one locality and belonging to one individual. The fragments of a jaw-bone, containing teeth much broken, were found about three-fourths of a mile from the house. This was the specimen which Harlan took to London, and from which Owen named the animal.

Judge Creagh was among the first settlers of Alabama, and he often told me of the large number of bones which were on his and the adjoining plantations, when he first moved there, how they interfered with the tillage of the soil, and how vast numbers of them had been burned and otherwise destroyed; and he added that an old hunter who lived among the Indians prior to the settlement of that country by the whites, had often told him that he had seen several entire skeletons of this animal, lying upon the surface of the ground, upwards of a hundred feet in length.

Zeuglodon Cetoides.—In addition to the foregoing remarks of Mr. Buckley, we take this opportunity of presenting an outline sketch of the head and one of the teeth of this animal, which were drawn for us by Mr. Russell Smith of Philadelphia, from the skeleton which has been fancifully called the *Hydrarchos*, by Koch. The head, as measured by Dr. Wyman,* is five feet seven inches long. "That part purporting

Fig. 1.

to be the cranium proper, and which serves more especially to protect the brain, consists apparently of a single bone and is destitute of any visible sutures, is a little more than one foot long, about five inches wide, and has, attached laterally by cement, two bones forming incomplete zygomatic arches. Inferiorly it is so much covered with cement, that little or nothing can be seen of its surface. Posteriorly there are no condyles, nor any foramen for the passage of the spinal marrow; in fact no foramina are any where visible. These characters lead to the

* Proceedings of the Boston Soc. of Nat. Hist., Nov. 1845, p. 65.

supposition that it is not the true cranium, but that it may be some bone or fragment not in its natural position. The size of the supposed cranium is obviously too small for lodging the brain of an animal 114 feet long, inasmuch as its cavity, if it had one, can exceed but little that of the spinal canal, which is visible in some of the vertebræ." "The jaw has been crushed by violence," and the fragments, sometimes inverted, are held together by the natural matrix, in which the whole was originally imbedded.

Two of the cochleæ of the ear of the Zeuglodon, were detected by Prof. H. D. Rogers,* among the loose bones of Koch's collection. They are about the size of a small lemon, and display that variety of the whorled or convoluted form of the cochlea, peculiar to the Cetacea.

Fig. 2.

Two-thirds natural size, lineally.

The teeth of this animal vary much in size and form, as may be seen by comparing the annexed figure with those lately published by Dr. Emmons,† from the skeleton brought to Albany by Mr. Buckley, and also with those published by Dr. R. W. Gibbes‡ of South Carolina, under the name of *Dorudon serratus*. The figure here given shows very perfectly the *yoked* form of the teeth, from which Prof. Owen has derived the name Zeuglodon. It is one third less than the natural size. No perfect series of the teeth of this animal has yet been seen by a good anatomist, "and we are therefore ignorant what are the varieties of form which such a series would present,

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* Proceedings of the Boston Soc. of Nat. Hist., Nov, 1845, p. 79.

† Am. Quarterly Journal of Agriculture and Science, vol. iii, p. 228.

‡ Proceedings of the Acad. of Nat. Sci. of Philadelphia, June 1845, p. 254.

in different parts of the same jaw." It is interesting to know that the geographical range of this animal has been carried so far east as the Santee canal in South Carolina, from whence the teeth and portions of the jaw, figured by Prof. Gibbes, were taken, being imbeded in the green sand marl.

With regard to the skeleton exhibited by Mr. Koch as the Hydrarchos, Dr. Wyman concludes, 1st, that these remains have never belonged to one and the same individual; 2d, that the anatomical character of the teeth indicates that they are not those of a reptile, but of a warm-blooded mammal. It is worth mentioning, as an instance of the accuracy and skill of the joiner of the Hydrarchos, that the extremities of the so called paddles of this skeleton, were formed of "*casts of a camerated shell, a species of nautilus*"*!* of which, specimens, brought from the state of Alabama, and now in the cabinet of the Academy of Natural Sciences, were shown to Prof. Wyman, by Dr. Morton of Philadelphia.*

2. *Mastodon Giganteus.*—The publication of Prof. Owen's "British Fossil Mammalia and Birds," has supplied us with the means of presenting our readers with a most perfect and elaborate portrait of the fine specimen of this animal, which is now standing in the British Museum. Mr. Owen says, (p. 298,) "The almost complete skeleton of the *Mastodon giganteus*, so well known to the public as the "*Missouri Leviathan*," when exhibited, with a most grotesquely distorted and exaggerated collection of the bones in 1842 and 1843 in the Egyptian Hall, Piccadilly, but now mounted in strict accordance with its natural proportions, in the British Museum, has enabled me to present, in the subjoined cut, (see next page,) as perfect a representation of the mastodon, as that of the mammoth given at the head of the preceding section."†

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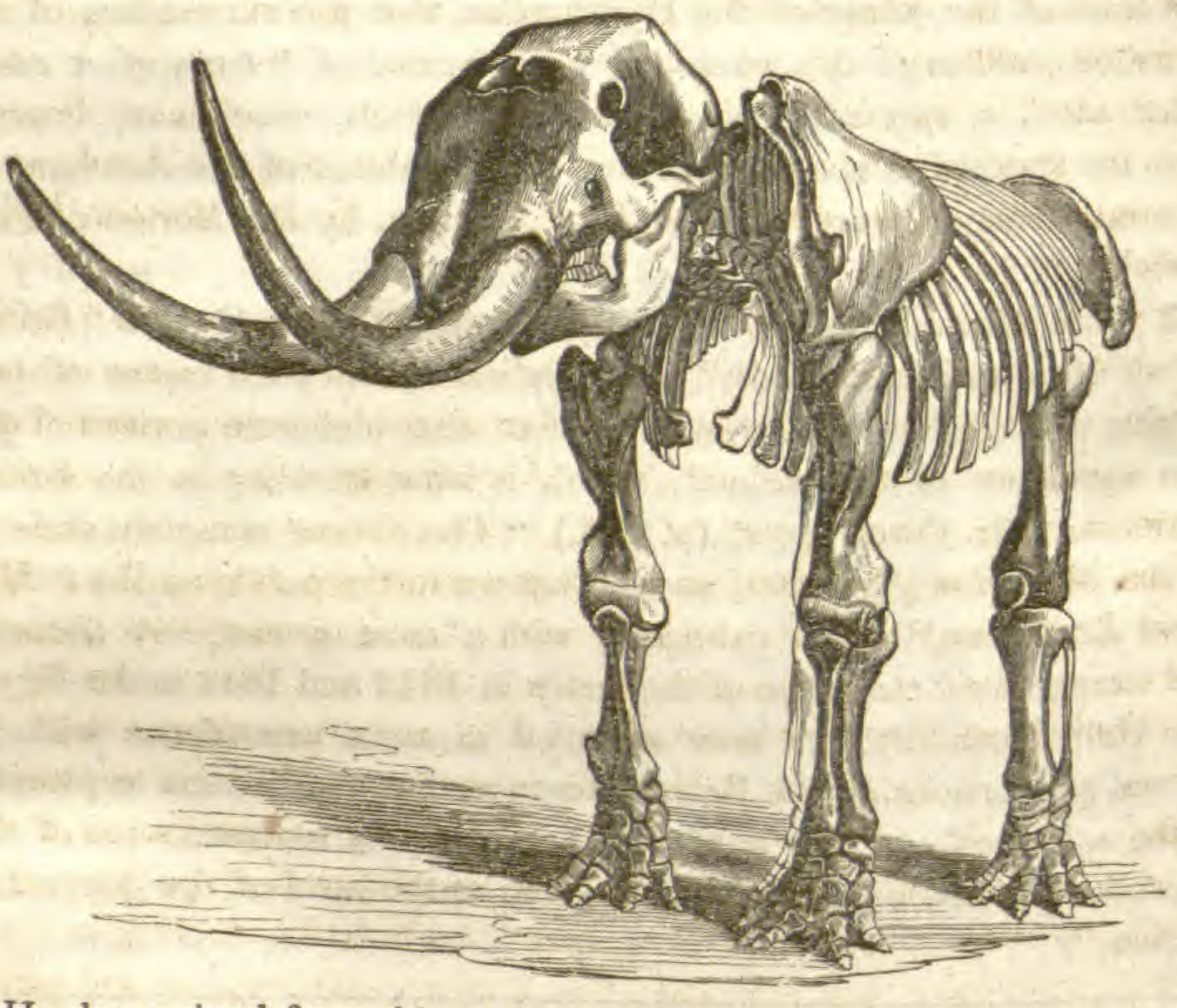
* Having received more than one application from respectable persons, unacquainted with comparative anatomy, to express an opinion as to the character of Koch's Hydrarchos, we will only say, that if the foregoing remarks, the testimony of one of the best comparative anatomists in America; the evidence of Mr. Lyell and Mr. Houston, (vol. i, p. 313) and of Dr. Lister; (Proceedings Bost. Soc. Nat. Hist. Feb. 26, p. 94) are not sufficient to convince the most credulous of the fictitious character of this skeleton, perhaps their faith in the skill of the joiner may be enlightened by a perusal of the following note on the mastodon. It is certainly not impossible that a Zeuglodon may be found 114 feet long; but if constructed by the same inventor, we might as well expect to see it 300 feet in length.

† Those who saw the "grotesquely distorted" monster, which was shown by Mr. Koch in this country, as the Missourium or Leviathan, will hardly recognize in the beautiful drawing on the next page, the same animal as restored by the accurate hand of Owen. The large lithographic print of the animal as mounted by Koch, which this person had executed at Dresden, will serve to convey to

In spite of much quackery and pretence, not only on the part of the notorious "author of the two largest known animals," (i. e. the "Missourium" here figured, and the *Hydrarchos*,) but also, from those, whose position and opportunities should have produced better things,* we have at length settled quietly down upon the true and well ascertained characters of the great American mastodon. Dr. J. B. S. Jackson has given us a lucid statement of the principal osteological characters of the mastodon.† His observations were made on the skeleton found at Schooley's Mountain in New Jersey in 1844, which was however deficient in the sternum, a few caudal vertebræ and the feet.



He determined from this skeleton, that the animal had twenty dorsal vertebræ, whereas Cuvier and Owen make but nineteen; this observation is confirmed by the skeleton found at Newburgh‡ last summer, (1845,)

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those who did not see this "anatomical fiction," a good idea of its awful proportions. It will be remembered as one characteristic of the genus "*Missourium*," that the tusks were placed at ninety degrees from their true position, pointing *outward* and backward. The trustees of the British Museum paid the owner, £1000 sterling (not "£2000") for this skeleton, and £300 additional for some accompanying bones. This we know from the very best authority.

* Proceedings of the Geol. Soc., June 15, 1842.

† Proceedings of the Boston Soc. Nat. Hist., Oct. 1, 1845, p. 60.

‡ American Journal of Science, Second Series, i, 269. See also a letter of Dr. Warren's to Mr. Owen, published in the Ann. Mag. of Nat. Hist., for March, 1846, No. iii, p. 145, in which he says the vertebral column has "7 cervical vertebræ, 20 dorsal, 3 lumbar, and the os sacrum." The ribs, 20 in number, are perfect.

and now in the possession of Dr. Warren.* Cuvier had suggested that one vertebral bone might be wanting, (*Ossemens Fossiles*,) and then that the number would be the same as in the elephant. The dentition of the animal has been satisfactorily made out by Mr. Owen, who finds *seven* teeth belonging to the series of the lower jaw, counting from the youngest.

It may seem unnecessary to state that the genus *Tetracaulodon* of Godman†, was clearly shown by Mr. Owen,‡ in 1842, to be only the immature state of both sexes of the *Mastodon giganteus* of Cuvier, and that in the male, one, at least, and usually the right, of the two lower tusks was retained, but that in the female both were lost as she approached maturity.

IV. Botany.

1. *Vegetable Physiology.*—M. Dutrochet in connection with M. Becquerel has shown that when a Chara is subjected to the action of an electric current, the peculiar circulation of this plant ceases for a while, and is recontinued after a certain period, if the current is unchanged; it is discontinued in the same manner with each change in the intensity of the current, whether the intensity is increased or diminished.

Variations of the temperature produce nearly the same effect, and it is also apparent on transferring the plant from fresh to salt water, and the reverse.

Electro-magnetism causes no effect. The circulation is not at all influenced by an electro-magnet capable of supporting near 2000 kilogrammes, whether at the establishment or breaking of the current, the reversing of the poles, or any other mode of operation.

M. Dutrochet concludes from these facts that the circulation in the Chara depends on a peculiar *vital force*, and not at all on electricity or magnetism, as the first of these, acts like all other exciting forces, and the second not at all.

2. *Distribution of the Vestiges of Palms in the Geological formations.*—Prof. Unger, in the work here cited, states, 1st, that no vestiges of palms have been detected in the earliest rocks which contain the organic remains of maritime and terrestrial plants. 2d. That palms bore some small part in the vegetation at the period of the coal formation, in which Ferns, Lycopodiaceæ, Lepidodendreæ, Calamiteæ, Cycadaceæ, and Coniferæ appear to have formed the principal growth. He names the following forms, viz.:—

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* See also the Am. Quarterly Journal of Agriculture and Science, vol. ii, p. 203.

† Transactions of the Am. Phil. Soc., New Series, iii, 478.

‡ Proceedings of the Geol. Soc., 1842.

Flabellaria borassifolia, *Sternb.* Coal schist, Swina, Bohemia.

Palæospathe Sternbergii, *Unger.* Ibid.

P. aroidea, *Unger.* Sandstone, Ural Mountains.

Zeugophyllites calamoides, *Brongn.* Rajemahl, North India.

Two undescribed species of Gœppert, from the coal formation of Silesia.*

3d. The flora of the red sandstone, although it has been very imperfectly preserved, and its scanty remains but little studied, Unger thinks was not materially different in type from that of the coal formation. But the fossils of this era which have been referred to palms, he thinks are very doubtful. Even in the variegated sandstone, which furnishes the remains of some other Monocotyledonous plants, no palms are found; nor are there any traces of them quite up to the *quadersandstein*, in which Gœppert found some vestiges in Silesia, (Flabellaria chamœropifolia.) From an older formation, the Oolite, the four species of Carpolithes described by Lindley and Hutton, may be mentioned.

4th. Finally in the tertiary, palms reappear, and the number of species far surpasses that of all the other formations together. In the eocene formation, there are,

Flabellaria parisiensis, *Brongn.*, from the chalk, near Versailles.

Palmacites echinatus, *Brongn.* Lower chalk strata, near Soissons.

Burtinia Faujasii, *Endl.* Lieblar, near Cologne.

B. cocoides, *Endl.* Woluwe, near Brussels.

The fruits called Nipadites by Bowerbank, belong to the same formation. In the miocene formation, we have—

Flabellaria Latania, *Rossm.*; "in arenaceo lignitum," at Altsattel, Bohemia.

F. raphifolia, *Sternb.*; in bituminous calcareous schist, at Häring, in Tyrol, Lausanne, Switzerland, and Piancourt, near Amiens.

F. oxyrhachis, *Ung.* Häring, Tyrol.

F. verrucosa, *Ung.* Ibid.

F. ? crassipes, *Ung.* Ibid.

F. Martii, *Ung.* Ibid.

F. major, *Ung.* Häring, Tyrol.

F. Hœringiana, *Ung.* Ibid.

F. maxima, *Ung.* In argillaceo-calcareous schist, at Radab, Croatia.

F. Lamanonis, *Brongn.* Gypsum schist. Provence.

Phœnicites pumila, *Brongn.*, among lignites, at Chartreuse, Puy en Velay.

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* As respects palm fossils of this age, see Brongniart, in Comptes Rendus, Dec. 1845, and in Ann. and Mag. Nat. Hist., Feb. 1846.

P. spectabilis, *Ung.* Calcareo-argillaceous schist, Radab.
P. salicifolius, *Ung.*, "in arenaceo lignitum," Altsattel.
P. angustifolius, *Ung.* Ibid.
Fasciculites didymosolen, *Cottæ, Ung.* Litmitz, Bohemia.
F. Cottæ, *Ung.* Locality unknown.
F. anomalus, *Ung.* do.
F. ? lacunosus, *Ung.* do.
F. palmacites, *Cottæ.* Tertiary at Chemnitz ? Antigua ?
F. perfossus, *Ung.* Altsattel, Bohemia.
F. Partschii, *Ung.* Locality unknown.
F. Fladungii, *Ung.* do.
F. sardus, *Ung.* Bonarvo, Sardinia.
Baccites cacoides, *Zenk.* Altenburg, Saxony.
B. rugosus, *Zenk.* Ibid.
Endogenites. Brongn. Prodr. p. 208. Horgen, near Zurich.

In the pliocene formation, there are—

Flabellaria antiguensis, *Ung.* Island of Antigua.
Palmacites crassipes, *Ung.* Ibid.
Fasciculites antiguensis, *Ung.* Ibid.
" Withami, *Ung.* Ibid. A. GR.

3. *Analogy between the Flora of Japan and that of the United States.*—Prof. Zuccarini, the author, in conjunction with Dr. Siebold, of the excellent *Flora Japonica* now in progress, (which we have more than once noticed in this Journal,) has recently published the first part of a brief memoir, entitled, "*Floræ Japonicæ familiæ Naturales, adjectis generum et specierum exemplis selectis :* Sect. 1, *Plantæ dicotyledoneæ polypetalæ.*" It is interesting to remark how many of our characteristic genera are reproduced in Japan, not to speak of striking analagous forms. Thus the flora of Japan has not only Wistaria, Lespedeza, Sieversia, Chimonanthus (in place of our Calycanthus), Philadelphus, several species of Rhus closely resembling our own, and two peculiar genera of Juglandeæ, but also a Pachysandra, some Berchemias, a Staphylea, and a peculiar genus of the tribe (Euscaphis), besides, not only a dozen Maples but also a Negundo, a Stuartia, two Tilias, a Phytolacca, an Opuntia (surely not indigenous ?), a Sicyos referred to our own S. angulata, two Droseras, a Nelumbium, a Nuphar and two species of Nymphea, Gynandropsis, a real Dicentra (Dielytra) and an allied new genus, with several species of Corydalis, a Trollius, our own Coptis and two new ones like the western C. asplenifolia, an Isopyrum, two species of Aquilegia, one of them near A. canadensis, a Cimicifuga, a Trautvetteria, an Illicium, some Magnolias, Kadsura and Sphærostemma in place of Schizandra, a Mitellopsis, two species of Astilbe (Hoteia), many Hydrangeas as well as peculiar

Hydrangeaceous forms, a Hamamelis with two other characteristic genera of the family, some true Dogwoods, as well as Benthamia the analogue of our Cornus florida, some true Vines, and two species of Ampelopsis, three species of Panax, and four of Aralia, one of which is near our A. nudicaulis: and among Umbelliferæ are Hydrocotyle, Sanicula, Sium, Angelica, but what is most remarkable, Cryptotænia, Archemora, and Osmorhiza! Further cases of generic conformity abound in the remaining divisions of the vegetable kingdom; thus, for example, Diervilla, Mitchella, Maclura, Liquidambar, Torreya, and Sassafras! are represented in the flora of Japan. A. Gr.

4. *Conspectus of the Fossil Flora.*—Prof. Unger, in his *Synopsis Plantarum fossilium*, pp. 296, 297, and also in his treatise *De Palmis fossilibus*, contributed to the 8th fasciculus of the great work of Martius on palms, gives the subjoined summary of the number of fossil species now known, under the several classes to which they are supposed to belong.

Algæ, ...	119	Aquaticæ, ...	1
Characeæ, ...	6	Iulifloræ [Amentaceæ, etc.],	93
Lichenes, ...	1	Oleraceæ, . . .	1
Fungi, ...	9	Thymeleæ, . . .	17
Musci, ...	2	Contortæ, . . .	11
Calamariæ [Equisetaceæ and Calamiteæ], . . .	109	Nuculiferæ, . . .	1
		Petalanthæ, . . .	1
Filices, ...	444	Discanthæ, . . .	1
Hydropterides [Sphenophyllum], ...	11	Polycarpieæ, . . .	1
		Nelumbia, ...	2
Selagines [Lycopodiaceæ, Lepidodendreæ, etc.], .	207	Peponiferæ, . . .	1
		Columniferæ, . . .	14
Zamieæ, ...	100	Hesperides, . . .	2
Glumaceæ, . . .	11	Acera, ...	19
Enantioblastæ, . . .	2	Frangulaceæ, . . .	4
Coronariæ [Lilia], . .	13	Tricoccæ, ...	1
Scitamineæ [Musaceæ], .	14	Terebinthineæ, . .	20
Fluviales, ...	21	Calycifloræ, . . .	5
Spadicifloræ [Pandanocarpum etc.], ...	18	Myrtifloræ, . . .	2
		Rosifloræ, ...	2
Principes [Palmæ], .	43	Leguminosæ, . . .	45
Coniferæ, ...	141	Plantæ incertæ sedis, .	118
		Numerus omn. spec.	1648

The *classes* here given are those adopted by Endlicher. A. Gr.

V. Astronomy.

1. *First Comet of* 1846; (L'Institut. No. 638, March 25, 1846.)—This comet was discovered Jan. 24, 1846, in the constellation *Eridanus*, by the Astronomers at the Observatory of the College at Rome. Although its light was feeble, it showed occasionally a distinct nucleus, and a small fan-shaped tail. It was observed up to March 4th, and probably somewhat later. The following approximate elements of its orbit were obtained by the Roman Astronomers.

Perihelion passage,	1846, Feb. 24·7789
Long. of Perihelion,	119° 38′ 21″
" " Asc. Node,	114 7 36
Inclination,	42 59 40
Perihelion distance,	1·37155
Motion,	direct.

2. *Second Comet of* 1846.—The comet discovered February 26, 1846, by Mr. George P. Bond, at the Observatory of Cambridge, Mass., an account of whose elements was given in this Journal, ii. Ser. i, 447, 448, had been previously detected on the 20th of that month, by the Astronomers at Rome. It was followed until about the 20th of May. Its orbit has much resemblance to that of the comet of 1707.

3. *Third Comet of* 1846.—On the 26th of Feb., 1846, Mr. Brorsen at Kiel, in Holstein, discovered a telescopic comet near η *Piscium*. Its parabolic elements computed by Mr. Petersen of Altona, are given below, by Mr. Schumacher, together with the elements of Apian's comet of 1532 referred to the ecliptic of 1846·0. Its elements agree also very nearly with those of the comet of 1661.

	Brorsen.	Apian.
Perihelion passage	1846, Feb. 27·4451 Berl. m. t.	Oct. 20·1532
Long. of Perihelion,	116° 25′ 12″	116° 28′
" Asc. Node,	96 21 32	92 3
Inclination,	32 34 10	32 36
Perih. distance in miles,	61,906,560	58,845,120

Prof. Encke considers this to be a comet of short period, and gives for it the following elements.

Perihelion passage	1846, Feb. 24·02410 Berl. m. t.	
Long. of Perihelion,	116° 11′ 57″·5	} M. Eqx. 1846.
" Asc. Node,	106 4 25·5	}
Inclination,	29 29 30·8	
Perih. distance,	0·662	
Angle of Excentricity,	45 26 9·2 = 0·71247	
Log. mean dist.	0·357566 = 2·2780 Semi ax. maj.	
	3·211123 Ax. min.	
Mean daily motion,	1031″·95	
Period,	yrs. 3·43874 = 1256 days.	

4. *Fourth Comet of* 1846.—On the 15th of March, 1846, Mr. Brorsen, of Kiel, discovered near *iota Leporis*, another telescopic comet. It was very faint, and the moon just rising, prevented any accurate observation. On the 17th he thought he perceived the body in about 80° 15′ R. A., and about 13° S. decl. On the 21st at Hamburgh, M. Rümker found its place to be at 8^h 59^m 29·6, Ham. m. t., R. A. 88° 4′ 16″·2, and S. decl. 14° 8′ 34·6. On the 27th, at his observatory in Kensington, Sir James South observed its place to be at 8^h 44^m 11^s. m. t., R. A. about 101° 9′, and S. decl. about 14° 35′ 2″. The comet was extremely faint, of an irregular figure, without any appearance of a nucleus, and under the most feeble illumination of the field of his five-feet equatorial, it became invisible.

5. *Fifth Comet of* 1846—*Bond's Comet.*—On the 19th of May, 1846, Mr. George P. Bond, of the Observatory of Cambridge, Mass., discovered in the constellation *Lynx*, another telescopic comet, of considerable brightness. The following approximate elements of the orbit of this comet have been furnished by Prof. Peirce, of Harvard University.

Perihelion passage,	1846, June, 4·2454 Gr. m. s. t.	
Perihelion distance,	0·64612	
Inclination,	29° 16′·5	
Longitude of the Asc. Node,	264 5·9	Mean Eqx. of
" " Perihelion,	164 23·7	Jan. 1, 1846.
Angle from node to perihelion,	99 42·2	
Motion,	retrograde.	

These elements are derived from the subjoined places determined by Mr. Bond. They are referred to the mean equinox and equator of Jan. 1, 1846, and are satisfied by the foregoing elements, within five seconds of arc.

Camb. m. s. t.	R. A.	N. Decl.
1846. May 19^d 12^h 15^m 2^s	6^h 34^m 58^s·45	51° 31′ 6″·4
21 9 11 44	6 44 5·07	48 55 48· 0
22 9 1 38	6 47 44·48	47 43 00· 0

6. *Observations on the Solar Eclipse of April* 25, 1846.

1. *Burlington, N. J.* Lat. 40° 4′ 51″·6 N. Observation by Mr. Samuel J. Gummere, with refractor of 42 inches focus.

Beginning,	10^h 48^m 46^s m. s. t.
End,	Sky overcast.

2. *Providence, R. I.* Observation by Prof. Caswell.

Beginning,	11^h 11^m 40^s·5 A. M., mean solar time.
End,	1 51 20 P. M.
Duration,	2 39 39·5.

A separate observation by Mr. H. Rice, gave

Beginning,	11^h 11^m 37^s.
End,	1 51 19.
Duration,	2 39 42.

3. *Charleston, S. C. College.* Observation by Prof. Lewis R. Gibbes.

Beginning,	lost.
End,	1^h 4^m 16^s·5.

VI. Miscellaneous Intelligence.

1. *Waves of the Atlantic and German Ocean;* by T. Stevenson, (Trans. Roy. Soc. Edinburgh, xvi, 23.)—Mr. Stevenson's experiments were made on the waves in the Irish Sea, the German Ocean, and the Atlantic at Skerryvore. To obtain results an instrument was contrived, which he calls a Marine Dynamometer. It consists of a circular plate to receive the impinging wave, which acts upon a powerful steel spring enclosed in a cylinder; and it is so arranged as to be self-registering. The following are among the results obtained, with other observations by Mr. Stevenson.

In the *Atlantic Ocean*, according to the observations made at the Skerryvore rocks, the average of results for five of the *summer* months during the years 1843 and 1844, is 611 lbs. per square foot. The average results for six of the *winter* months (1843 and 1844) is 2086 lbs. per square foot, or thrice as great as in the summer months.

The *greatest result* yet obtained at Skerryvore was during the heavy westerly gale of 29th March, 1845, when a pressure of 6083 lbs. per square foot was registered. The next highest is 5323 lbs.

In the *German Ocean*, according to the observations made at the Bell Rock, the greatest result yet obtained is 3013 lbs. per square foot.

It thus appears, that the greatest effect of the sea, which has been observed, is that of the Atlantic at Skerryvore, which is nearly equal to three tons per square foot.

These experiments, amounting to 267 in number, and on the Atlantic alone extending over 23 months continuously, are not intended to prove any thing farther than the simple fact, that the sea has been known to exert a force equivalent to a pressure of three tons per square foot, however much more. Now, when we consider that the hydrostatic pressure due to a wave of 20 feet high, is no more than about half a ton on a square foot, we see how much of their force the waves owe to their velocity. There can be no doubt, however, that results higher than this will be obtained.

I shall now contrast the indications of the Marine Dynamometer, by stating a few facts regarding the ascertained effect of the waves in the elevation of spray, and in the transportation of heavy masses of rock. This is more especially important, as to some, the results indicated by the instrument have appeared greater than they could have expected; and it has even been supposed that, were they correct, the stones which constitute our marine works would be scattered.

In the Frith of Forth, at the Granton Pier works, on 19th December, 1836, after a gale from the northeast, one stone was moved measuring fifteen cubic feet, or about one ton in weight, and thrown on the beach, after having been built into the wall; and a stone containing 18 cubic feet was moved 30 feet from its place; while the *pierres perdues* or mound stones were washed down to a slope of about 4 to 1.

The following instance, which occurred at the landing slip of the Calf Point, Isle of Man, affords a proof of the great force of the waves even in the Irish Sea. During a gale from the northwest, a block was lifted from its place in the wall and thrown landwards, which measured $123\frac{1}{2}$ cubic feet, equal to about 10 tons weight.

In the German Ocean, we can refer to the Bell Rock Lighthouse, which, though 112 feet in height, is literally buried in foam and spray to the very top, during ground swells, when there is no wind. It is, therefore, a very important station for making such experiments, because the rise of the spray may be regarded as a scale by which the results of the Marine Dynamometer can be checked or compared.

In the published account of this work there occurs the following statement:—On the 24th October, 1819, the spray rose to the height of 105 feet above the rock. "It may, perhaps, therefore," says the author, "be concluded, that the maximum force of the sea at the Bell Rock is to raise the sprays to the height of about 105 feet above the surface of the rock;" and deducting 16 feet, which is the height that the tide rises upon the tower, there is left 89 feet, as the height to which the water is raised. This is equivalent to a hydrostatic pressure of about $2\frac{1}{2}$ tons on the square foot. Since that time, however, there have been still greater proofs of the force of elevation. On the 20th November, 1827, the spray rose 117 feet above the foundations or low water mark; and the tide on that day rose 11 feet upon the tower, leaving 106 feet as the height of elevation, (exclusive of the trough of the sea,) being *equivalent to a pressure of very nearly* 3 *tons per square foot.*

At the island called Barrahead, one of the Hebrides, a remarkable example occurred during a storm in January, 1836, in the movement of a block of stone, which, from measurements taken on the spot, is 9 feet $\times$ 8 feet $\times$ 7 feet $=$ 504 cubic feet, which, allowing 12 feet of this gneiss rock to the ton, will be about 42 tons weight. This great mass was gradually moved 5 feet from the place where it lay, having been rocked to and fro by the waves till a piece broke off, which rolling down, and jamming itself between the moving mass and the shelving rock on which it rested, immediately stopped the oscillatory motion, and thus prevented the farther advance of the stone.

Mr. Reid, the principal keeper of Barrahead lighthouse, the assistant keeper, and all the inhabitants of the little island, were *eye witnesses* of this curious exhibition of the force of the waves; and Mr. Reid also gives the following description of the manner in which they acted upon the stone.

"The sea," he says, "when I saw it striking the stone, would wholly immerse or bury it out of sight, and the run extended up to the grass line above it, making a *perpendicular* rise of from 39 to 40 feet above the high water level. On the incoming waves striking the stone, we could see this monstrous mass of upwards of 40 tons weight lean landwards, and the back run would uplift it again with a jerk, leaving it with very little water about it, when the next incoming wave made it recline again. We did not credit the former inhabitants of the island, who remarked that the sea would reach the storehouse which we were building; and when these stones were said to have been moved it was treated with no credit, and was declared by all the workmen at the lighthouse works to be impossible; yet the natives affirmed it to be so, and said if we were long here we might yet see it. They seemed to feel a kind of triumph when they called me to see it on the day of this great storm."

2. *Cotton in India;* (Athenæum, No. 964, p. 398.)—Dr. Royle communicated to the Asiatic Society on March last, a letter from Dr. Wight, relative to the progress which the cultivation of cotton is making in India, and showing a degree of success and magnitude of produce far exceeding what had been expected. He stated that 30,000 lbs. have been already gathered, and "one field, of which regular accounts are kept, has already yielded 700 lbs. per acre."

3. *Roman Coins.*—In a field in the commune of Plourhau, (Côtes-du-Nord,) the discovery has been made of an immense number of Roman coins, estimated at no less than 18,000 or 20,000. The heap weighs sixty kilogrammes. The pieces include a great variety of types—many representing mythological subjects—and are generally in good preservation. Most of them appear to present at least nineteen centuries of antiquity; and they are conjectured to have belonged to some detachment of Roman troops obliged suddenly to quit the country, who may have buried them in the hope of some day returning to reclaim them.

4. *Anthracite and Bituminous Coal in China;* by R. C. Taylor, (Phil. Mag. March, 1846, xxviii, p. 204.)—It is probable that coal was discovered, and was in common use in China, long before it was known in the western world. It is mentioned by a noble traveller of the 13th century, as abounding throughout the whole province of "Cathay," of which Pekin is the capital, "where certain black stones are dug out of the mountains, which stones burn when kindled, and keep alive for a long time, and are used by many persons, notwithstanding the abundance of wood."

The good missionaries were fully capable of describing the coals which were supplied to Pekin, since they there erected a furnace or stove, in which they experimented on the properties of those combustibles; particularly with reference to the ordinary domestic uses, and for the warming of apartments and the purposes of their laboratory.

Among the people of Pekin three kinds are in use.

1. That employed by the blacksmiths. It yields more flame than the other qualities; is more fierce, but is subject to decrepitate in the fire; on which account, probably, the blacksmiths use it pounded in minute particles.

2. A harder and stronger coal, used for culinary purposes, giving out more flame than the other sorts so employed; it is less quickly consumed, and leaves a residuum of gray ashes. There are several gradations of these. The best are hard to break, of a fine grain, a deep black color, soiling the hands less than the others. It sometimes is sufficiently siliceous to give fire with steel. Others have a very coarse grain, are easily broken and make a bright fire, leaving a reddish ash. Another species crackles or decrepitates when first placed on the fire, and falls down, almost entirely, in scales, which close the passage of the air, and stifle the fire.

3. A soft, feeble burning coal, giving out less heat than the 2nd class; consuming more quickly, it breaks with greater facility, and in general is of deeper black than the sorts previously mentioned. It is commonly this description which, being mixed with coal-dust and a fourth part of clay, is employed to form an artificial and œconomical fuel. This being moulded in the form of bricks and balls is sold in the shops of Pekin. Wagon-loads of coal dust are brought to that city for this sole purpose.

The coal merchants have also an intermediate quality between the classes 2 and 3.

We cannot in this place recite the numerous details which are furnished by these intelligent Fathers. Suffice it to add, that nearly all of the properties and applications are now in every-day use in the United States, and are familiar to all. They are, in fact, the natural results suggested by qualities possessed in common by the combustibles of remote parts of the same globe. Even the modern method of warming all the apartments of our dwellings, which we view as the result of superior practical and scientific investigation, was in use, with little deviation, centuries ago by the Chinese. Many a patented artificial fuel compound both in Europe and America, has been in practical operation in China at least a thousand years.

4. *Anthracite.*—Another description of coal abounding about thirty leagues from Pekin, but which was not then in such general use there

as the other kinds, is called by the Chinese Che-tan. Che means a stone, but tan is the name they give to wood-charcoal. Therefore, according to the genius of the Chinese language, this compound word signifies a substance resembling or having the common properties of stone and charcoal. There can be little difficulty here in recognizing the variety of coal which in our day has been denominated anthracite, a compound word of similar meaning.

The Chinese *glance coal* forms a remarkable exception to the unfavorable conclusion prevailing against Oriental coal; and, according to more recent authority than those we before cited, deserves to rank at the head of the list, in respect to its purity as a coke, although in specific gravity it does not come up to the character of the Pennsylvania or Welsh fuel; neither has it the spongy texture which contributes much to the glowing combustion of the latter.

So late as 1840, a Russian officer described the coal formations of the interior, as occupying the western mountain range of China, in such abundance that a space of half a league cannot be traversed without meeting with rich strata. The art of mining is yet in its infancy among the Chinese; notwithstanding which, coal is thought to be at a moderate price in the capital. Anthracite occurs in the western range of mountains at about a day's journey, or thirty miles only, from Pekin. The coal formation is largely developed, in which thick beds of coal occur. They appear to be of various qualities. Some of this coal, occurring in shale beds, is singularly decomposed, and its particles have so little cohesion, that they are almost reduced to a state of powder. Beneath these coal shales are beds of ferruginous sandstone, and below those occur another series, consisting of much richer seams of coal than the upper group.

Coal in other parts of China.—The Missionaries and others inform us that coal is so abundant in every province of China, that there is perhaps no country in the world in which it is so common. The quays at Nankin are stored with the finest native coal. Some of the coal which was brought down to the coast, from the Pekin country, to the Gulf of Pe-tchee-lee, was anthracite, partaking of the character of plumbago or graphite. Coal, apparently of the brown coal species, exists extensively in the direction of Canton; while all the coals seen on the Yang-tse-kiang river, south of Nankin, resembled cannel coal. Nearer to Canton it possessed the comparatively modern character of the brown coal. It was abundantly offered for sale in the different cities through which Lord Amherst's embassy passed, between the lake Po-yang-how and Canton, and the boats were largely supplied with it. It is there obtained by means of pits, like wells; and we infer that, like nearly all the brown coal deposits, the beds were horizontal, and at no great depth. A sulphurous coal, interstratified with slate, and in the vicinity of red sandstone, also prevails towards Canton.

5. *Chair of Anatomy at Edinburgh;* (from the Ann. Mag. Nat. Hist. for May, 1846.) We are happy to hear that Mr. John Goodsir has been elected to the important office of Professor of Anatomy in the University of Edinburgh. The original and highly philosophical essays of that gentleman have gained him an European reputation as an anatomist and physiologist, whilst his services in the cause of natural history have placed him in an equally high position as a biologist. His memoirs on the *Amphioxus* and *Orthagoriscus*, on the anatomy of many mollusca, radiata, and entozoa, and on certain vegetables parasitic on animals, are familiar to the readers of the 'Annals.' Anatomy and natural history will equally gain by this excellent appointment.

6. *Association of Geologists and Naturalists.*—This Association holds its next annual session in the city of New York in September, commencing with the 2d of the month. Dr. C. T. Jackson will preside as Chairman of the meeting. A list of the officers and the standing and local committees, will be found on our advertising sheet.

7. *Officers of the American Academy for the Current Year.*—Jacob Bigelow, M. D., *President;* Hon. Edward Everett, LL.D., *Vice President;* Asa Gray, M. D., *Corresponding Secretary;* Oliver W. Holmes, M. D., *Recording Secretary;* J. Ingersol Bowditch, *Treasurer.*

8. *Concord Natural History Society.*—The Concord (New Hamp.) Natural History Society has commenced with much zeal, and we trust that it will receive the favor and substantial patronage of the intelligent community among whom it is established. At the first meeting in April, the following persons were chosen as officers for the ensuing year:—Dr. Wm. Prescott, *President;* Hon. N. G. Upham, Paul Wentworth, Esq., *Vice Presidents;* Wm. Kent, Esq., *Recording Secretary;* Asa Fowler, Esq., *Corresponding Secretary;* I. F. Williams, Esq., *Treasurer;* Wm. C. Prescott, *Librarian and Cabinet Keeper;* Dr. T. Haynes, Dr. C. P. Gage, Richard Bradley, Esq., Abiel Chandler, *Managers.*

Obituary.—*Died*, on the 5th of May last, at Boston, the Hon. John Pickering, an eminent counsellor and an equally eminent scholar. The bar of Suffolk County, in a commemorative resolution, say—"His learning, the accumulation of a long life of study, embraced nearly every branch of human knowledge, without omitting any part of what was appropriate to his profession. His fine powers and great accomplishments were adorned by a native modesty, which attracted the most enduring confidence of his fellow men. His rare and cultivated taste, his kind and gentle manners, his fidelity to every relation, his laborious diligence, his public services, his profound scholarship, his pure and spotless nature are honored on this mournful occasion, by his brethren, as they will long be cherished by the whole community." We have only to add to this very just delineation, our deep personal regret, from a friendly intercourse of several years.—B. S.

Death of Bessel.—Frederick Wm. Bessel, one of the most celebrated astronomers of the age, died after a most distressing illness, at Königsberg, in Persia, on the 17th of March, 1846, in the 62d year of his age.

Deceased Members of the Royal Society.—The anniversary address of the president furnishes us with the names of several distinguished men, who have deceased during the past year.

Dr. William Heberden, a distinguished author on Hygiene ; he died on the 19th of February, 1845, aged 77.

John Frederick Daniell.—We have already noticed the death of Prof. Daniell, which took place on the 13th of March, 1845, by a fit of appoplexy, at the age of 55, having been born in London 12th March, 1790. It is a remarkable proof of the variety and extent of Mr. Daniell's acquirements, that he received at different times, all the medals in the gift of the Royal Society.

Jaques Dominique Cassini, Comte du Thury, at the age of 97. He was the fourth in direct descent of a family, which, during nearly two centuries, has been singularly illustrious in the history of the sciences, and particularly of astronomy. He was the fifth of his family who had been elected a member of the Académie des Sciences.

Théodore de Saussure of Geneva, son of the celebrated Alpine traveller, and an illustrious vegetable physiologist, botanist, and meteorologist. He died April 18, 1845, aged 78.

Bibliography.

1. *Synopsis of the Fishes of North America;* by D. Humphreys Storer, M. D., A. A. S., &c. (4to. Cambridge, pp. 298.)—This work was prepared in answer to a call from the Association of American Geologists and Naturalists, for a paper on the "Comparative Ichthyology of North America and Europe," and was read to that Association at their meeting in New Haven, May, 1845. Subsequently it was presented to the American Academy of Arts and Sciences for publication, and constitutes one of the papers of the volume of their transactions, just from the press.

We look with no little gratification upon this addition to American Zoölogical literature, by an American naturalist. Both the design and the execution are most happy. When it was undertaken, no work embodied descriptions of any considerable portion of North American fishes. Since then, the labors of Dr. Dekay have, in some measure, supplied this deficiency. Nevertheless, a compact work, which might be readily consulted, exhibiting at one view a list of all the fishes that have been noticed, a concise description of them, and references to figures and more full descriptions, and whatever had been published concerning them, was just the thing wanted; and it was something which could not be effected without great research and labor. This has now been accomplished, by untiring perseverance, during hours stolen from severe professional duty, under much physical disability as we happen to know, and in a manner which reflects great credit upon its author.

No one who has not undertaken thus to gather in, from volumes in various languages, from scientific and literary periodicals, and even from newspapers, the scattered descriptions of objects, then plotting them out into a harmonious whole, and thus opening a fair field on which future investigations may rest, can have a just idea of the labor requisite. In the present instance we notice that not less than seventy-five different volumes, many of them rare and difficult of access, have been consulted. Dr. Storer has thus placed this little library in the hands of every student of American ichthyology. Nothing tends more to throw a chill over the ardor of inquiry, than the apprehension that we may be laboring upon what is already understood, or the consciousness that we have no means, without disproportionate labor, of gaining satisfaction on the point. On the other hand, nothing tends more to encourage the solitary inquirer than the conviction, that whatever he observes which is not noticed in a certain book before him, is pretty sure to be novel. In spite of the want of facilities, ichthyology, like the other branches of zoölogy, has already many worthy votaries among us, as the names of Dekay, Holbrook, Kirtland, Ayres, Olmsted and Storer, will attest. But we may now safely predict that the work before us will bring out an army of recruits, who, by possessing themselves of the scientific treasures about them, will speedily augment greatly the list now published.

Dr. Storer's list enumerates 741 species, belonging to 221 genera and 35 families. In it are included all the fishes that have been noted as inhabitants of all the waters which wash the coast of North America, the south and west as well as the north and east. The character of each family, genus and species are given, with the localities of the last, and the authority for the localities, and also a very full list of synonyms. The descriptions of all the fishes which have been seen by

Dr. S. are made out in his own terms; the others have been translated or abridged, as the case required, from the language of the original describers. Besides the descriptive portion there are also several interesting tables relating to the geographical distribution of the fishes. These show those *genera* which are found both in Europe and America—those found in North America and not peculiar to it, but not found in Europe—those peculiar to America—those found in North, and extending to South America. Again, we have tables of the *species* found both in Europe and North America—of those extending from North into South America—and of those peculiar to the North-West Coast.

We think of nothing, that could render the work more valuable as a manual, except that it were published in a manner to admit of its more extensive diffusion among actual laborers.

2. *The Naturalist, and Journal of Agriculture, Horticulture, Education and Literature;* conducted by I. N. Loomis, J. Eichbaum, J. S. Fowler, and T. Fanning, at Franklin College, Tennessee, in monthly numbers of 48 pages.—The first number of this monthly journal was issued in January. It is devoted to the dissemination of information on science and its applications, and to useful miscellaneous intelligence, besides original articles in natural history. The number for March contains a catalogue of the fluviatile shells of the family Naiades of Jefferson Co., Ky., by B. F. Shumard, M. D., of Louisville; also remarks on the Geology of Harpeth Ridge, Davidson Co., Tennessee.

3. *Elements of Physiology, including Physiological Anatomy, for the use of the Medical Student;* by Wm. B. Carpenter, M. D., F. R. S., &c., &c., (Lea & Blanchard, Phil. 1846; 8vo. pp. 566—180 cuts.)—Dr. Carpenter is so well known in this country to all physiological and medical readers, by his several works on general, human, and vegetable physiology, that no comment is required from us on the present work, which covers some of the most interesting branches of the wide domain of physiology. This author is not merely the compiler of other men's ideas, (although every elementary author must be so to some extent,) but he is among the most active investigators in his science, in Great Britain. His recent researches on the microscopic structure of shells, are before the world in the last volume of the reports of the British Association, and a notice of his important discoveries may be found in this Journal, ii. Ser. i, 283. The work is arranged and adapted for the elementary use of the student of medicine, and is thoroughly brought up to the day.

4. *American Quarterly Journal of Science, conducted by* E. Emmons and A. Osborne, Esq. Albany: $2 per annum.—The third volume of this agricultural journal has been completed, and it sustains the high

character of the previous volumes. The sciences of agriculture and mining, subjects of great importance to the state of New York and to the whole country, are presented in a full and yet popular manner. No. 1 of vol. III, contains, besides other original articles, an account of the copper mines of Lake Superior, with a map; a report on the resources of Orange county for manures; on salt as a fertilizer: and No. 2 of the same volume, presents its readers with a memoir on the agricultural geology of Onondaga county, with many analyses of soil and rocks; an article on Irish agriculture; another on European agriculture; an account of the Zeuglodon with figures of several bones. Besides these and other memoirs, there are copious excerpts of agricultural and scientific interest.

4. *Manipulations in the scientific arts:* 1. *Photogenic Manipulation*, in two parts; by G. T. FISHER, Jr. 2. *Electrotype Manipulation*, in two parts; by C. V. WALKER. Small 18mo. pp. 110 and 150. Reprinted from the London edition. Philadelphia: Carey & Hart.

These useful little treatises are timely, and cannot fail to promote an intelligent application of science to the arts, in two of the most remarkable and useful discoveries of modern times.

5. *Turner's Chemistry*, 7th edition, with notes and additions; by JAMES B. ROGERS, M. D., and ROBERT E. ROGERS, M. D. Phil. 1846. Thos. Cowperthwaite & Co. 8vo. pp. 848.—A new edition of Dr. Turner's Elements was much needed in this country: it has had a most deserved popularity here as well as in England, as one of the best treatises on elementary chemistry which has ever appeared. The present edition has been brought down to the present time by a number of judicious notes added by the Messrs. Rogers.

6. *Monthly Miscellany and Journal of Health;* edited by W. M. CORNEL, M. D., $1 per annum.—This journal was commenced the 1st of January last. It contains much good reading, and valuable intelligence, and information on health, of a popular character.

7. *A History of British Fossil Mammals and Birds; by* RICHARD OWEN, F. R. S., F. G. S., etc. *Illustrated by* 237 *wood cuts.* London: J. Van Voorst, Paternoster Row. 1846. 8vo. pp. 560.—This volume is one of a uniform series of works, publishing in London by Mr. Van Voorst, comprising a complete zoology of the British Islands. Mr. Owen's late labors, undertaken at the request of the British Association for the advancement of Science, on the remains of British fossil vertebrate animals, have peculiarly fitted him for the present task. The chapter on the Proboscidian animals we have read with peculiar interest. The beautiful figure of the *Mastodon giganteus*, at p. 132 of this volume, is a fac simile of that given by Mr. Owen, and is a fair sample of the high style of art in which all the wood cuts of this volume are

finished. *Such* figures worked into the page, quite supersede the necessity of more costly and less convenient copper plates.

The introduction to the present volume must be read with delight by all who feel any interest in the past history of our globe, as drawn from organic evidences. We shall take pleasure, as far as it may be practicable, in making from this chapter and other parts of this 'History,' such extracts and abstracts as will be most likely to interest our readers.

8. *Thoughts on Animalcules, or a Glimpse of the Invisible World revealed by the Microscope;* by GIDEON ALGERNON MANTELL, Esq., LL. D., F. R. S., &c. 1846.

Notes of a Microscopic Examination of Chalk and Flint; by the same Author. 1845.

The wonders revealed by the microscope are becoming every day more interesting and instructive. At the head of the works on this subject, stands Ehrenberg's magnificent folio, illustrated by sixty-four colored plates.

"The reader who has not seen this work, can have no adequate idea of the fantastic shapes, and the almost endless variety of form and structure which animal existence assumes, even in our own planet, in the regions from which the microscope withdraws the veil."

The Thoughts on Animalcules of Dr. Mantell are contained in a beautiful little volume of 144 pages, containing twelve exquisitely figured and colored plates of living animalcules, drawn from nature and greatly magnified. This work is in keeping with all others of the same distinguished author, not only in eloquence of thought and diction, and in minuteness and accuracy of research, but in the minor excellencies, of paper, print, and binding.

Excellent microscopes are now prepared in London and Paris at prices within the reach of most literary and scientific institutions, and of many individuals, by which the wonders he describes may be easily demonstrated from specimens found in almost every pond and pool of water. The principal divisions of the work are—

1. The ideal invisible world. 2. The invisible world revealed by the microscope. 3. The Hydra or fresh-water polype. 4. The divisibility of vitality. 5. Cells the essential organs of life. 6. The Infusoria or fresh-water animalcules. 7. The Polygastria. 8. The Monads. 9. The Vorticellina or bell-shaped animalcules. 10. The Rotifera or rotating animalcules. 11. The Floscularia or flower-shaped animalcules. 12. Stephanoceros or crowned wheel animalcule. 13. The Rotifera or wheel animalcule. 14. Animalcules with durable cases or shells. 15. Reflections. 16. General Remarks, Conclusion, Appendix, Notes, &c.

The principal value of the work is in prompting observation and rendering the objects accessible in common circumstances, to all persons who can have the use of a microscope of considerable power. Thus they will become convinced that where nothing is seen by the naked eye, or at most a scum or a slight cloudiness or a little jelly-like matter adhering to immersed vegetables, there are often forms of exquisite structure and beauty, some of which are little more than mathematical points, but possessing all the organs necessary to their existence and functions. A world is thus revealed to our view of whose existence we have ordinarily no evidence.

In treating of *Final Effects*, the author expresses his decided conviction "that no well regulated mind can rise from the contemplation of the marvels revealed by the microscope, without being so deeply impressed with a sense of awe, of humility, and of dependence, as to be secured from the arrogance and presumption of attempting to interpret the final purposes of the ETERNAL, even in the minutest of his works. We may indeed take cognizance of some of the obvious results of the operations of these living atoms; such for instance as their influence in maintaining the purity of the atmosphere and of the water, by the conversion into their own structure of the particles liberated by the decomposition of the larger animals and vegetables; and in their turn becoming the food of other races, and thus affording the means of support to creatures of a higher organization than themselves. We see too that many species after death give rise to the formation of earthy deposits, at the bottom of lakes, rivers, and seas, which in after ages may become fertile tracts of country and the sites of large communities of mankind."

The Notes on the Microscopic Examination of Chalk and Flint, are highly interesting and instructive, and fully support the conclusion, that animalcules, corals, and foraminifera or polythalmia have been largely concerned in these formations, and that thermal or hot water rendered potent in dissolving silica by the aid of heat and pressure and alkalies in solution, has been efficiently operative in the solidification of organic bodies, and an appeal is carried up to operations of nature now going on under our eyes, and to the results of actual experiment, which can leave no doubt that the principal, although it may not be the exclusive cause of silicification, is that just indicated.

9. *Harvey's Phycologia Britannica.*—Of this work, which was barely announced in the bibliography of our last number, the following notice has appeared in the London Journal of Botany for May last:—

"Four numbers of this beautiful work are already before the public, and the judgment of that public has been pronounced upon it. We believe of its merits there can be but one opinion, viz. that at no period of botanical literature has a more important contribution been made to the Flora of the British Isles than on the present occasion. Of Dr. Harvey's fitness for the descriptive portion of the work, a moment's doubt could not be entertained; but it adds infinitely to the value of the plates to know that not only are the drawings and analysis all executed by Mr. Harvey's own hands, but the plates (lithographs) also; thus ensuring the most perfect accuracy to the figures as well as the letter-press. The work will be completed in sixty numbers, and each number contains six colored plates at the moderate price of 2*s.* 6*d.* These appear without reference to systematic order, but at the conclusion of each volume, and more fully at the completion of the entire work, systematic and alphabetical indexes will be added; and finally a general introduction, to be prefixed to the last volume, will complete the history. The plates represent the natural size of magnified dissections of the species, accompanied by generic and specific characters, synonyms, British habitats, the geographical distribution and general history of each individual, in a fuller and more perfect manner, than has yet been attempted in any work exclusively devoted to the illustration of British Algæ."

In Great Britain the sea-weeds have long been favorite objects of study, and are perhaps as well known as many tribes of phænogamous plants; while with us they have been almost universally neglected. We hope that this neglect will not continue. Our species, especially those of our northern shores, being mostly the same as those of the north of Europe, this work of Dr. Harvey, and his former Manual of British Algæ, will do much to facilitate their study with us, in default of native writings on this branch of botany. To call attention to the subject, and to show how easily persons of leisure, who reside upon or visit the coast, may render essential assistance to those specially occupied with this department, we venture to copy a portion of a private letter of Dr. Harvey's soliciting such collections:—

"I have in contemplation other illustrated works on the foreign species, and am therefore very desirous of specimens from all parts of the world. From North America I have nothing! except a few from the west coast. Your long line of coast must contain many good things. They are easily dried, and make very pretty objects especially admired by *lady botanists.* Have you none of this class in America, who would like the amusement of picking sea-weeds on the shores? Here we have many, and some of our best observers are ladies. Good-natured persons who will merely visit the shore and pick up by hands-full whatever is seen; dry them like hay in the sun, without washing; pack them roughly when dry in a common packing case, and forward them in this state to Europe, will do us at this side the water an essential favor. Such collections, if made with a very slight degree of care, so as to ensure a variety of species, and especially from your southern states would be very acceptable. The best time for collecting is at spring tides, when many species can be reached which are otherwise covered. The best kind (as a general rule) grow nearest *low-water mark* and beyond it."

It will give the writer of this notice great pleasure to forward to Dr. Harvey such collections of our Algæ as may be entrusted to his charge, and to return sets authentically named to those who are desirous of making these exquisitely beautiful plants the subject of scientific study.

A. Gr.

10. Lindley's *Vegetable Kingdom, or the Structure, Classification and Uses of Plants, illustrated upon the Natural System*, (London, 1846, pp. 908, 8vo., with upwards of 500 illustrations,) is, as it were, an enlarged and greatly modified edition of this author's former *Introduction to the Natural System of Botany.* We propose to offer a somewhat detailed notice of it in the next number of this Journal.

A. Gr.

11. Martius, *Genera et Species Palmarum.*—The 8th fasciculus of this splendid work, published last September, has come to hand. It comprises, 1st, the concluding sheets of the systematic portion; 2d, a full account of Fossil Palms, by Prof. Unger, of Gratz, who, by the way, has recently published, at Leipsic, a *Synopsis Plantarum Fossilium*, in a single 8vo. volume, which will be very useful to geologists; and 3d, a dissertation on the growth and morphological structure of Palms, by Prof. Von Martius himself. His conclusions respecting the structure and growth of the palm-stem, differ materially from those of Desfontaines, De Candolle, as well as from the view of Gaudichaud, but are nearly in accordance with the views recently maintained by Misbel, in his memoir on the date-palm, &c. A. Gr.

12. *The Geology of Russia in Europe, and the Ural Mountains;* by Sir R. I. Murchison, Prest. Lond. Geol. Soc. &c. &c.; Edouard de Verneuil, Prest. Geol. Soc. of France, &c. &c.; and Count Alexander Von Keyserling, Gent. of the Chamber of H. I. M. Nicholas 1st: in two volumes 4to. Vol. I. *Geology*, (in two parts) by Mr. Murchison, pp. 700, with geological maps, sections, and numerous illustrations. Vol. II. (part third, in French,) *Palæontology*, by MM. Verneuil and Count Keyserling, pp. 512, with 50 plates of fossils; published at London and Paris, 1845. (Price in London, £8.)

These invaluable volumes appeared in London in January, and a copy some time since reached us, by the liberality of Sir Roderick Murchison and Mr. Verneuil. The distinguished author of the "Silurian System" needs no praise at our hands; and his not less distinguished associates have ably coöperated, by their united labors and sacrifices, to raise this lasting monument, worthy of their own fame and of Imperial liberality. As may be seen by the title, Mr. Murchison is the author of the first volume, which embraces the structural geology, not only of the wide extended horizontal steppes of central Russia, from which Mr. Murchison has formed the "Permean" system; but also the complex hypogene rocks of the Uralian Mountains, stretching from north to south over 16° of latitude, and forming the eastern barrier of Europe. All this is drawn out in lucid detail and fully illustrated by excellent geological maps and sections. The pencil of Sir Roderick has also illustrated his eloquent text, by numerous lithotints of characteristic and picturesque scenes. Within the space of a bibliographical notice no adequate idea can be given of even the general scope of this noble work. But we have in the present number,* given abstracts of some topics, and shall, as opportunity offers, continue to cite such passages as may be most interesting to our readers.

The second volume, in French, by M. Verneuil and Count Keyserling, is entirely devoted to a description of the numerous paleozoic fossils, with the most admirable lithographic drawings of each species. A general '*coup d'œil*' of the paleozoic fauna of Russia is prefixed to this volume, the whole of which must be of the greatest moment and interest to American geologists, a large portion of whose domain so much resembles (in its paleontology) the steppes of Russia—both being rich in the peculiar forms of the Silurian era.

The general interest in these volumes is much increased at the present moment, by the recent arrival in the United States of M. VERNEUIL, one of the authors, who will pass the summer in making a rapid reconnaissance of our ancient fossiliferous deposits. We feel assured that, wherever his researches may take him, he will find those whose familiarity with our fossils will be equaled only by the satisfaction they will feel, in making known their results and displaying their collections to a distinguished savant, whose familiarity with paleozoic geology is at least as great as that of any living authority. M. Verneuil, as acting president of the Geological Society of France, is virtually the representative of European geology; but we are sure that this official distinction is not necessary to secure him those useful and agreeable attentions, which his affability and manly frankness will so well repay.

LIST OF WORKS.

Catalogue of the Plants of Lewis County, N. Y.; by F. B. HOUGH, A. B., published by the Senate of the State of New York, (from the Report of the Regents of New York, 1846.)

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* See notices of Gold, Platina and Diamonds, on pages 119 to 123.

Fifty-ninth Annual Report of the Regents of the University of New York, made to the Legislature, March 1, 1846. 283 pp. 8vo. *Albany*, 1846. Contains full meteorological reports for the year, from the several school districts of the state.

Monographie des Coléoptères subpentamères de la Famille des Phytophages, by M. Th. Lacordaire. *Brussels and Liepsic*, 1845.

Danmarks Fiske, by Henrik Kröyer. *Copenhagen*, 1845.

Abbildungen und Beschreibungen neuer oder wenig gekannter Conchylien, A. Philippi. *Cassel.*

Horæ Tergestinæ, oder Beschreibung und Anatomie der im Herbste 1843 bei Triest beobachteten Akalephen, von J. G. F. Will. *Liepzig.*

Taylor's Scientific Memoirs, part xv, containing—*Biot*, on the employment of polarized light; *Neumann*, on a photometrical method of estimating the intensity of light; *Köne*, on the nature of aqua regia, and on the constitution of hyponitric acid; *Riess*, on the incandescence and fusion of metallic wires by electricity; *Dové* on the periodical variations in the pressure of the atmosphere.

Treatise on the Oscillations of the Barometer, with particular reference to the meteorological phenomena of November 1842, by W. Brown, Jr. *London.*

Bryologia Europæa, by Bruch, W. P. Schimper and Th. Gümbel. *Stuttgart.*

Sur le Climat de Belgique, A. Quetelet. 4to. *Brussels*, 1845.

Iconografia della Fauna italica, C. L. Buonaparte. Folio, *Vienna.*

Iconographie der land- und süsswasser Mollusken, E. A. Rossmassler. 4to. *Dresden*, 1845.

Grundzüge der Kristallographie, J. Müller. 8vo. *Brunswick*, 1845.

Traité complet de Minéralogie, by A. Dufrénoy. Three large volumes in 8vo. *Paris*, 1845, 1846.

Geschichte der Chemie, H. Kopp. *Brunswick*, 1845.

Handwörterbuch der reinen und angewandten Chemie, by Liebig, Poggendorff, and Wöhler. *Brunswick*, 1845.

Annuaire de Chimie, E. Millon and J. Reiset. 1 vol. 8vo. *Paris*, 1846.

Leçons d'anatomie comparative, tome viii, contenant les organes de la génération et des sécrétions; par Georges Cuvier et G. L. Duvernois; 2nd ed., 1 vol. 8vo. *Paris*, 1846.

De Candolle's Prodromus, vol. x; embracing the Boragineæ proper, by the late De Candolle, revised and completed by his son; the Hydroleaceæ, by Choisy; the Scrophulariacea, by Mr. Bentham; with a full index of the genera and synonyms of the whole ten volumes of the Prodromus. *Paris*, April, 1846.

SCIENTIFIC RESEARCHES.

Memoirs of the American Academy of Arts and Sciences, Cambridge, vol. ii, new series. Page 1. An account of the Magnetic Observations made at the Observatory of Harvard University, Cambridge, by Joseph Lovering, and W. Cranch Bond, A. M.

Page 85. An account of the Magnetic Observations made at the Observatory of Harvard University, Cambridge. Communicated by Joseph Lovering.

Page 161. On the practice of Circummeridian Altitudes at Sea or on Shore. By Captain W. F. W. Owen, R. N.

Page 183. The latitude of the Cambridge Observatory, in Massachusetts, determined from Transits of Stars over the Prime Vertical observed during the months of December, 1844, and January 1845, by Wm. C. Bond, Major James D. Graham, and George P. Bond. By Benjamin Pierce.

Page 205. On the Language and Inhabitants of Lord North's Island in the Indian Archipelago; with a vocabulary. By John Pickering, President of the Academy.

Page 248. A vocabulary of the Soahili Language, on the eastern coast of Africa; by Samuel K. Masury. Communicated by Charles Pickering, M. D.

Page 253. A synopsis of the Fishes of North America. By David Humphreys Storer, M. D.*

PROCEEDINGS OF THE BOSTON SOCIETY OF NATURAL HISTORY.†—1845, vol i, p. 1. Species of new shells from Jamaica; C. B. Adams; (*genera*, Marginella, Erato, Mitra, Columbella, Buccinum, Purpura, Fusus, Pleurotoma, Cerithium, Rissoa, Eulima, Chemnitzia, Monodonta, Turbo, Scalaria, Nerita, Neritina, Fissurella, Patella, Chiton, Perna, Arca, Cardita, Thetis, (n. gen.) Lucina, Amphidesma, Tellina, Psammobia, Cyclostoma, Helicina, Truncatella, Pedipes, Succinea, Bulimus, Achatina, Cylindrella, Pupa, Helix, Paludina, Melania, Planorbis.)—Page 18. New shells from the Sandwich Islands; Dr. J. W. Mighels; (*genera*, Helix, Helicina, Pupa, Bulimus, Partula, Achatina, Achatinella, Succinea, Physa, Paludina, Sigaretus, Solarium, Turbo, Cerithium, Pleurotoma, Triton, and Cypræa, including 51 species).—Page 26. New shells from the Sandwich Islands; A. A. Gould; (*genera*, Achatina, Stomatella, Trochus, Columbella, Cypræa, Achatinella; 12 species.)—Page 33. On the Infusoria of the Mississippi; J. W. Bailey.—Page 37. New shells from Liberia, west coast of Africa; A. A. Gould; (*genera*, Pholas, Psammobia, Tellina, Nucula, Nassa, Helix; 7 species.)—Page 47. New species of fish (Etheostoma cœrulea) from Chicago, Mich.; D. H. Storer.—Page 48. New species of fish from Alabama; D. H. Storer; (*species*, Leuciscus croceus, L. prolixus, L. obesus, L. gibbosus, Etheostoma tessellata, E. cinerea.)—Page 49. New species of fish from Ohio, (Exoglossum dubium,); J. P. Kirtland. —Page 51. New species of fish (Pœcilia olivacea,) from Alabama river; D. H. Storer.—Page 53. Two new Unios from the everglades of Florida; A. A. Gould.—Page 55. New genera and species of Plants; A. Gray and G. Engleman; (new genera, Thysanella and Brazoria, and several new species.)—Page 57. On the native and black oxyd of Copper of Lake Superior and their formation; C. T. Jackson.—Page 59. Two new species of Linguatula; J. Wyman.—Page 59. On the existence of the sack of the dart, and of the dart, in several species of North American pneumobranchiate Molluscs; J. Leidy.—Page 60. On the Mastodon giganteus of Schooley's mountain, N. J.; C. T. Jackson.—Page 65. On the so-called Hydrarchos Sillimani; J. Wyman.—Page 73. A new Syngnathus (S. Californiensis) from California; D. H. Gould.—Page 74. Trochilus yucatanensis, a new humming bird; Dr. Cabot.—Page 76. Leptocephalus Morrisii, a new species of fish; D. H. Storer.—Page 77. Prionotus pileatus, a new species of fish; D. H. Storer.—Page 78. Argyreiosus unimaculatus, a new species of fish; J. M. Batchelder.—Page 79. On the cochlea of the Zeuglodon, also on boulder trains in Berkshire; H. D. Rogers.

1846, *February* 4, page 98. New species of shells from Tavoy, A. A. Gould; (*genera*, Helix, Bulimus, Pupa, Succinea, Melania, Amnicola, Nucula; in all 9 species.)—Page 101. New Bulimus from Brazil; A. A. Gould.—Page 102. New shells from Jamaica, by C. B. Adams; (*genera*, Planorbis, Cyclostoma, Helicina, Pupa, Lima; in all 5 species.)—*February* 18, page 103. Synopsis of the fishes of the state of Ohio; D. H. Storer.—*March* 4, page 106. Esox lucius, from Lake Champlain and Connecticut river; D. H. Storer.—Page 107. On Damourite from Chesterfield, and Pyrrhite from the Azores; J. E. Teschemacher.—Page 109. On fluate of lime in cannel coal; H. D. Rogers.—Page 110. On the mines of Lake Superior; C.

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* A notice of this memoir is given on p. 145 of this volume.

† The brief review of the Proceedings of American Societies, here commenced, will be continued in regular series, in the following numbers of this Journal.

T. Jackson.—*March* 18, page 115. A new genus of plants, Darbya, of the order Santalaceæ; Asa Gray.—Page 118. On the supposed identity of the Anas penelope and A. americana, and on the structure of the Tetrao cupido; S. Cabot, Jr.

PROCEEDINGS OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA, vol. iii, 1846. *February* 24, page 19. New Devonian, Tertiary, Silurian and Carboniferous fossil shells; T. A. Conrad; (*genera*, Cerithium, Tellina, Eulima, Odostomia, Delphinula, Bulla, Bonella, Calyptræa, Myodora, Ampullaria, Cancella, Cyathophyllum, Turbinolia, Madrepora, Monotis, Avicula, Strophomena.)—Page 23. New recent shells from Florida; T. A. Conrad; (*genera*, Cyrena, Venus, Nucula, Modiola, Astarte, Osteodesma, Solecurtus, Lucina, Corbula, Pallia, Murex, Marginella, Oliva, Trochus, Bulla, Crepidula, Dentalium.)—*March* 3, page 33. A fossil Asterias, with a figure, from Cincinnati, Ohio; Prof. Locke.—Page 34. On the difference of level between the waters of the Gulf of Mexico and those of the Atlantic; E. Harris.—Page 41. On the fossil Squalidæ of the United States, (37 species); R. W. Gibbes.—Page 44. On the Birds of Upper California; W. Gambel.

ANNALS AND MAGAZINE OF NATURAL HISTORY, *April*, 1846, No. 112. On the Tribe Spheriaceæ and descriptions of new genera; G. de Notaris.—On the genus Sitona, (Curculionideæ); J. Walton.—On the British Rubi; C. C. Babington.—Embryogeny, &c. of the simple Ascidians; M. Van Beneden.—Development of Chara; C. Müller.—On the occurrence of Tetraspores in Algæ; G. H. K. Thwaites.—New genus (Cynalicus) of Dogs; J. E. Gray.—Linnæan Society, June 17. New Chalcidites; F. Walker.—Entomological Society, Nov. 4. A new locust; F. W. Hope.—Entomological peculiarities of New Zealand.—Zoological Society, Oct. 14. On the genus Anous; J. Gould.—Two new birds from New South Wales; J. Gould.—New Ostreæ; S. Hawley.—New species of Murex; L. Reeve.—New species of Nerita, from Cumming's collections; C. A. Recluz.—*May* 1846, No. 113. New genus of Gasteropods; G. J. Allman.—On the British Rubi; C. C. Babington.—Development of Chara; C. Müller.—New Homopterous insects in the British Museum; A. White.—Species of Semnopithecus from Malacca; T. Cantor. Linnæan Society, Nov. 18. Anatomy of a Meloë; J. Newport.—Plants of the Gallipagos Islands; J. D. Hooker. Zoological Society, Oct. 28. New Neritæ, from Cumming's collections; C. A. Récluz.—New Pleurotomæ, from Cumming's collections.

ARCHIV FÜR NATURGESCHICHTE, No. iii, 1845. Synoptical table of Entozoa continued; von Gurlt, with an appendix by M. Creplin.—Review of works and memoirs on Mammalia, of the year 1844; A. Wagner.—Review of works and memoirs on Birds, for the year 1844; A. Wagner.—No. iv, 1845. Cryptorhynchus Lapathi, with a plate; Prof. Schwägrichen.—New Echinoderms, with a plate; A. Philippi.—Appendix to a Conspectus of birds, by J. J. von Tschudi.—Review of works and memoirs on Insects, Arachnida and Crustacea, for the year 1844; W. F. Erichson.

BULLETIN OF THE ROYAL ACADEMY OF BERLIN, (Bericht, &c.) November 1845. New Polygastrica and Polythalamia, with some new genera; Hr. Ehrenberg.

ISIS, (Leipzig,) No. i, 1846. Review of European Lepidoptera; C. F. Freyer.

VERHANDLUNGEN DER KAISERLICH LEOPOLDINISCH-CAROLINISCH ACADEMIE, vol. xxi, 1845. On Regelia, Beaufortia and Calothamno, genera of Myrtaceæ; J. C. Schauer.—Elatinarum Monographia; M. Seubert.—On the Mosasaurus Maximiliania; A. Goldfuss.—Spermatozoa of the Locustineæ; C. Th. von Siebold.—Microscopic examination of the liver and its secretions of Crustacea and Mollusca; H. Karsten.

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Local Committee for the next meeting.

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THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

Art. XIV.—*Notice of Baron Wolfgang Sartorius von Waltershausen's work on Mount Etna;* by J. L. Hayes.

The interest which attached to Etna in ancient times, when burning mountains were considered rare and accidental phenomena, and nearly all that was known of volcanic agency was derived from an observation of this remarkable mountain, has been in no respect diminished by modern discoveries, which have so much enlarged the sphere of igneous action, and have shown that those mysterious phenomena which were apparent exceptions to the harmony of nature, are necessary parts of the great machinery of the earth; for as our conceptions of the importance and magnitude of volcanic agency are enlarged, the more interesting is the theatre where its operations are best displayed.

The volcano is the point of departure to the geologist in his investigations of the most ancient revolutions of the globe. It repeats in his own times the phenomena of the disturbance and elevation of mighty masses of the earth's crust. It spreads before his eyes beds of crystalline rock, analogous to those formed in ancient periods. It exhibits a power still at work, which is inherent to the nature of the earth, and must have been active during its earliest epochs. But above all other volcanoes, and we may say above any other known point on the earth's surface, Etna is full of instruction to the geologist, as well as delight to all who would observe the terrible and beautiful in nature. The majesty of its proportions—the individuality, if we may so speak, of its form—the frequency and terrible effects of its eruptions, displaying every form of activity, in the flow of lava currents, the formation of lateral cones, and the uplifting of the solid basis of the mountain—the light which its internal structure throws upon some of the most difficult questions of volcanic geology—the fullness and authenticity of its history, going back to a more remote epoch than that of any other volcano, make Etna, the classic volcano, and its phenomena, types of all that is curious and wonderful in the most sublime agency of nature.

Etna has never been without its observers from the time of Pindar, who described it with such graphic skill. Notwithstanding the details respecting its structure and phenomena, presented in the works of the Sicilian savans, Recupero, Ferrara and Gemmellaro, whose lives were passed at the foot of the mountain, new and important facts have been made known by foreigners whose opportunities for observation have been limited, and particularly by Dolomieu, Spallanzani, Hamilton, Scrope, Hoffman, Abich and Lyell. The observations made by Elie de Beaumont in 1834, during a visit of only a few days, have thrown a flood of light upon the structure of this mountain, and seem almost to have resolved the great question as to the mode of elevation of the volcanic piles. But even this most acute observer acknowledges that all the materials for the construction of an edifice whose achievement would present the first interest to science, could not be condensed into a complete work, except by one who should make a prolonged sojourn upon the places to be described. Indeed nothing less than a faithful picture of this portion of the crust of the globe, founded upon all the observations of former explorers, prepared with all the appliances of modern science, and illustrated by the highest art, could satisfy the curiosity with which this remarkable spot is regarded.

These considerations will enable us to appreciate the service which has been done to science by the labors of a German savan, Baron von Waltershausen, who has finished and is now presenting to the world a complete history of Etna and its convulsions.

A brief personal sketch will convey the best idea of his fitness for the great work which he has undertaken, and lead us naturally to an account of his scientific labors.

Baron Wolfgang Sartorius von Waltershausen, now about 37 years old, was born in Göttingen. His father, a corresponding member of the French Institute, and a representative of one of the German States at the Congress of Vienna, is still well known on the continent of Europe as the author of an important and learned history of the Hanseatic cities and their league. From the intimacy existing between Göthe and the family of Baron Waltershausen, that great poet was his godfather, and gave him his own name, John Wolfgang. He was educated chiefly at the University of Göttingen, where his father was for some years a professor, lecturing with great reputation on History and Political Science, and refusing from his attachment to the place and its resources, frequent offers that were made to him of higher positions in the service of Russia and other German States.

But the son so far as intellectual occupation was concerned, showed no disposition to follow in his father's footsteps. From his earliest youth he discovered a passion for the study of nature, and especially of mineralogy and geology. When hardly seven years old, in a childish letter to a friend of the family, a distinguished scholar of this country, who was about to visit Italy, he said, "I am making a collection of mineral stones, and I wish I had some lava. If you go to Naples, pray send me a piece from Vesuvius." The passion thus early developed grew with his years, and after the death of his father, who died in his arms in 1828, and that of his mother, a lady of some accomplishments and personal attractions, which followed two or three years later, he found himself still young, in possession of a good fortune, and free to devote himself to the pursuit of his favorite sciences. His determination was at once taken, and he prepared himself by the most careful study, and by personal investigation of the mineralogy and geology of Germany, for the enquiries that he intended to make elsewhere.

He was satisfied however, that in order to do any thing for the advancement of the sciences to which he now devoted his life, he must avoid the common fault of extending his researches over too wide a field. After much consideration therefore, he selected a single point, Etna and its neighborhood, as the scene of his labors, determining to remain there until he should have accomplished whatever in the present state of knowledge could be undertaken for the explanation of its extraordinary phenomena.

As soon then as he could make the large arrangements necessary for his undertaking, in 1835–6, he hastened to Sicily, carrying with him such draftsmen, surveyors and other assistants as could be useful. He was delighted with the region so admirably chosen for enquiries intended to enlarge the boundaries of science, and establishing himself on the highest habitable point of the volcano, devoted himself with the greatest zeal, self-denial and perseverance to his task, until he had completed the most ample topographical and geological maps of the whole country, investigating at the same time its peculiar character with great minuteness, and preparing drawings and sketches of every thing that could illustrate his discoveries or their results.

In this great work he and his assistants spent seven years, until the "mad German," as the ignorant part of the population sometimes called him, had become as well known to the inhabitants of the island as the mountain itself.

At last in 1842, he returned to Germany, carrying with him a great work which he had completed amidst much personal exposure, peril and suffering, without support from any European government, and sustained only by the love of science and his own strong will. This work he is now publishing both in German and French, under the title of "Etna and its Convulsions." It is when completed to consist of two parts. The first part is to be an atlas folio volume of engravings, containing 1. A topographical chart of Etna and its neighborhood, drawn in the proportion of 1 to 50,000 in., from trigonometrical surveys made by himself, or under his own supervision, on 15 large folio sheets. 2. A corresponding geological map on 15 similar sheets, and 3. About 54 large engravings of views, sections and other sketches appropriate to the illustration of the whole subject; explanations of the plates accompanying each. The first number of this part of the work was published in Göttingen in 1845, and beautifully engraved by artists of much merit, one of whom, Cavallari, Baron von Waltershausen had in his service in Sicily, and took with him to Germany on account of his great skill in this particular department of topographical drawing and engraving. Five other numbers will follow at intervals of a year, making six in all, the price of each of which will be seven Spanish dollars.

The second part of the work is to consist of a thick quarto volume, containing after a general and scientific topographical introduction, the astronomical observations made to determine the localities, the base measurement and triangulation of the volcano; a minute topographical description of it; trigonometrical and barometrical observations to determine its height; an examination of its terrestrial magnetism; its mineralogy complete; a history of its eruptions from the days of the Licanians to the present time; its entire geology, with an account of its origin and of the changes it has undergone, as far as they can now be traced or recognized; and in conclusion, a discussion of the general theory of volcanoes, and a comparison of Etna with the Ligurian volcanoes, Vesuvius, and the volcanoes of the South of Europe. This part will be published as soon as it can be prepared.

This remarkable monograph, on which its author has so disinterestedly spent and is now spending the best years of his life and a large part of his fortune, is published wholly at his own expense, and without any expectation of being remunerated for his sacrifices, except by the reputation he will earn, and the consciousness of what he has done for the great cause of science and the progress of intellectual culture.

Thinking that there may be persons in this country who have a spirit like his own, and are interested in similar pursuits, he has sent, we are happy to say, a few copies of the first number of his work in French to a friend in Boston. They may be found on sale at Little & Brown's, booksellers, Boston. We need hardly mention that this is the same work of which some early specimens were presented by Hon. Nathan Appleton to the Association of American Geologists, at their meeting in Washington in 1844, and with respect to which resolutions of high commendation were passed by the Association.

Until the present time the model for labors in volcanic geology has been the elegant monograph by Leopold von Buch, the Physical History of the Canary Islands, which at the time of its appearance was justly esteemed the most beautiful geological work ever published. The highest praise that we can offer with regard to the execution of "Etna and its Convulsions," is to say that the illustrious work of the father of German geologists has been wholly surpassed by the genius and industry of his countryman.

We hope that this elegant and valuable work will find its way to the libraries of our men of science and fortune. It is a model which our best geologists and topographers may study with profit. It will exhibit to younger students in physical science, the rich rewards of concentrated and long continued labor, and it may excite some of our own countrymen to achieve among the unexplored volcanoes of the South, and on our western coast, conquests in science more glorious than those of victorious arms.

ART. XV.—*On Three several Hurricanes of the American Seas and their relations to the Northers, so called, of the Gulf of Mexico and the Bay of Honduras, with Charts illustrating the same;* by W. C. REDFIELD.

(Continued from Vol. I, p. 369.)

Review of the Phenomena and Characteristics of the Cuba Hurricane.

THE detailed observations and accounts which have now been submitted, afford us a comprehensive view of the two Cuba storms, in their daily progress, and may serve for enabling other inquirers to make a more complete analysis and generalization of the several phenomena than can be attempted on the present occasion. It will be my province to elucidate some of the more prominent facts and characteristics which pertained to these gales, and especially to the great hurricane.

TRACK OF THE STORM.—From what primary sources, or in what particular region this hurricane had its origin, or on what portion of the earth's surface it first took effect as an observable gale of wind, does not appear. Its observed route, as indicated by the foregoing recitals, appears nearly direct from the shores of Central America, crossing the islands of Cuba and Newfoundland, and may fairly be estimated as extending from Cape Honduras, lat. 16°, lon. 86°, to a point on the axis line opposite to the position of the *Independence* at noon of Oct. 8th, near lat. 50° 25′, lon. 49° 45′; which, following the axis route, exceeds *three thousand statute miles.* To what further extent this storm might be traced, does not distinctly appear.*

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* See Chart IV.

Rate of Progression.—This may be approximately shown by the following estimate of the progress of the storm's axis,—which, so far as known, coincided nearly with the observed minimum of the barometer, at the several points of observation. We commence from a point on the axis line opposite to the *Openango*, (recital 7,) about 9·30 P. M. on the 4th of October.

From No. 7	to opposite Key West	=246 miles	in 16½ hours;	*rate* 15 miles per hour.
" Key West	to lat. 27° 30′	=324 "	" 12½ "	" 26 " " "
" lat. 27° 30′	to lat. 31°	=302 "	" 7 "	" 43 " " "
" lat. 31°	to lat. 40°	=781 "	" 18 "	" 43·4 " " "
" lat. 40°	to lat. 45°	=480 "	" 14 "	" 34 " " "

Previous to the night of the 4th its progress may have been slower than the lowest rate here given.

(1.) We notice that while below the tropic, the rate of progression did not exceed that which has been found in several of the West Indian hurricanes moving in the same latitudes but following a widely different course. (2.) We find that a highly rapid, if not unexampled progression was acquired by this hurricane while on its course from the tropic to the usual exterior limit of the trade winds; in which region the progress of hurricanes has often been comparatively slow. Such former cases of retardation I have attempted to explain by the change from a westerly to an easterly progression; a change that does not appear in the Cuba storm. (3.) We find that the most rapid advance of this storm was from the northern border of the trade winds to the parallel of 40° or 42°; this being the region, in which, if I mistake not, the permanent currents of the lower atmosphere are commonly found in their fullest activity. (4.) We here ascertain a gradually decreasing rate of progression in the latitudes beyond 40°, which has probably occurred in other storms, and which, in connexion with other causes, may serve, in some degree, to explain or account for the extent and complication of the barometric waves and other meteorological phenomena in the higher latitudes.

The average progression of the storm from the Bahamas to latitude 45°, may be stated at forty miles per hour.

So far as is yet known, the most rapid progression has been attained by those storms which have pursued the most northerly courses, in their progress from the lower latitudes. The highest rate previously known, in the American seas, appears to have been about thirty miles an hour; while in the case before us the rate, through perhaps twelve degrees of latitude, appears to have exceeded *forty-three miles an hour.*

The integral progression of the great storms of the lower atmosphere may be viewed as affording data of great value for any investigations of the actual course of atmospheric circulation, or of the great planetary laws by which this circulation is chiefly maintained.*

Lateral Diameter of the Storm.—In determining the full diameter or breadth of the storm, across its path, it is somewhat difficult to mark an approximate limit of its action on either side of its axis, independently of any deficiency in the observations. Thus it might be questioned whether we should test its extent (1) by the observed prevalence of an active storm-wind, at the surface only,—or (2) by the entire extent of the conformable or vorticular winds at the earth's surface,—or (3) by the presence and observed movements of the lower stratum of storm-clouds, as connected with the foregoing,—or (4) finally, by the more widely extended effects on the barometer.

We may conclude, however, that the broadest lateral extent over which the winds of this storm prevailed in observable strength at the surface, or in which the weather exhibited a stormy appearance, or effect, exceeded a diameter of nine hundred miles and perhaps equalled one thousand; while the general breadth of the *gale*, as one of ordinary, as well as extraordinary force, may be estimated as, at least, eight hundred miles.†

This last, if taken as the average width of the storm path and multiplied by the observed length of the latter, as before estimated, indicates an area of *two millions and four hundred thousand square miles*, which was swept over, with more or less violence, by this gale; an extent nearly three times greater than all the territory of the United States east of the Mississippi.

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* It may be proper again to state, that the results of the author's inquiries on the courses of winds, and their relations to temperature, in different regions, and at different elevations, have constrained him to relinquish the common theory that heat is the sole or main cause of wind, or progressive motion, in a planetary atmosphere.

He has been aware of the disadvantage in which this avowal may tend to place him, in the minds of many votaries of science whose approbation it would be his happiness to obtain. The proper elucidation of this question, he conceives, will belong to the future.

† See recitals 2*a*, 2*c*, 22, 25, 26, 44, 69, 154, 99, 106, 107, &c.

CHART V. *Showing the Daily Progress of the Cuba Hurricane with the Direction of Wind at the hour of 6 A.M. on the 5th 6th & 7th days of October, respectively 1844.* CHART V.

The numbers show the places or vessels named in the recitals.

Engd by J.M. Atwood, N.Y.

The width of that portion of the track in which was exhibited either the violence of a hurricane or that of a severe or destructive gale may be estimated to exceed *five hundred miles.**

Diameter of the Storm on its Center Path.—The diameter of the storm-wind from front to rear might be directly determined by the distance from a point in front to another in rear at which it severally began or ended at the same time; provided that we could obtain good hourly observations which should so coincide. An available substitute for this method is found in plotting the observations for a given hour, on successive days, as on Chart IV, and the other charts which follow. Thus the distance between the two several positions assigned to the axis of the storm at noon on the 5th and 6th days of October, respectively, is 784 miles. Now the *Demarara*, (45*b*,) in front of the gale on the 5th, was brought to reefed topsails as early as 8 A. M.; while at noon on the 6th, after an advance or drift of 88 miles in the Gulf Stream, this vessel remained hove to, and did not set reefed topsails till 1 P. M.; nor let out reefs and make full sail till 6 P. M., a period of 34 hours. This authorizes an estimate of 1084 miles for this diameter of the storm as a reefed topsail gale.

The distance between the two axis positions on Chart IV for noon of the 6th and 7th, respectively, is 950 miles, and the observations of the winds and minimum of the barometer on board the *Pique* frigate appear to show that the storm figure for noon of 7th should have been placed thirty miles further in advance, making the distance between the two axial points equal to 980 miles. Now, even at Bermuda the strength of the gale was marked 6 at two hours before noon of 6th; and, more in front, the gale was strong with the *Wakulla* (148) at noon, and continued to blow a gale till noon of the 7th. These facts indicate a diameter of more than a thousand miles. These estimates include neither the incipient nor the closing moderate and light winds which were conformable with the body of the gale.

Another good estimate of the diameter in this direction is obtained by multiplying the rate of progress by the whole duration of the storm wind, at the several points where the observations have been most complete. If we apply this to the entire observations at Key West, (38,) about 48 hours, with an *average* rate

* Recitals 11, 20, 66, 118, 136, 156, and others.

of 15 miles for the first 26 hours, and of 32 miles for the last 22 hours, we have 1094 miles for this diameter. The like estimate applied to the observations on board the *Demarara*, (45*b*,) with the increased rates of advance, and deducting the vessel's progress, will give a result fully equal to the foregoing. These conclusions may be sustained, also, by a like reference to the recitals mentioned below.*

These results cannot be invalidated by the reports which are less determinate, nor by those which refer only, or chiefly, to the more violent portion of the gale. They are satisfactorily tested by the fact that the daily advance of the gale, which from lat. 27° to 42° was equal to 1032 miles per day, does not, in all cases, afford space on the chart sufficient for the separate daily delineation of all the observations of the earliest and latest wind of the storm.

We may hence conclude that the entire extent of the gale on its line of progress was somewhat greater than its lateral diameter; unless we admit that, on its southeastern border, the gale was extended much beyond our points of observation on that side. Its limitation on the left or continental side, owing probably to the obstructions and elevations of the surface and the pressure of the natural currents from the western board, is more distinctly determined.

The diameter of the violent portion of the gale, in the direction of its progress, does not appear to have been less than in the transverse direction.†

Revolving Character of the Storm-Wind.—As regards the general manner in which the wind was exhibited in this case, as well as in other great storms, I can find no ground for the support of opposite or dissimilar conclusions.

On a general review of the observations, the following state of facts is presented to our notice. (1.) In the early part or front of the storm, on its centre path, we find the wind to have blown from the southeastern quarter, transversely from the right towards the left side of the path. Continuing to follow this wind in its course, as we depart from the axis path the observations show it to proceed successively from more eastern and northeastern points,

* Nos. 72, 86, 100, 118, 121, 123, 129, 130, 141, 142, 144.

† This will be seen on an examination of the data presented in cases 35, 38, 64, 70, 71, 121, &c.

till, on the passing of the gale's axis, it has veered so far to the left as to blow from northern and northwestern points of the horizon, thus turning gradually towards the center path, and, finally, recrossing it, in the rear of the storm's axis, on the fair-weather or clearing-up side. See observations in Table I; which follows. We find, indeed, in some localities, that a portion of the successive changes in the wind's direction have occurred somewhat suddenly, or with some irregularity, but this will not invalidate the general result of the observations.

(2.) If now we place ourselves again in the front of the storm, on its center path, and follow *back* the first southeasterly wind towards its apparent source on the right hand side of the storm path, the observations will show, that as we recede from the axis line and the storm advances, the wind comes, successively, from points more and more southward or southwesterly, till, on the passing of the gale's axis, it comes from points successively more westward and leading us again towards the axis line, on the posterior side of the storm, till, finally, we find ourselves in the same northwesterly wind from which we had parted at the end of our first semi-circuit of the gale. See the successive observations in Table III.

In thus tracing the circuit of the wind, on the two sides of the storm-path, we have followed the order in which the wind's changes are severally presented to observers. We have seen that these changes have been in *opposite courses of succession*, on the opposite sides of the axis path, viz. from the right towards the left, on the left hand side of the path, and from the left towards the right, on its right hand side. But if we follow out our first trace continuously round the circuit, from the rear to the front of the storm on its right side, being the constant direction from right to left, ↺, we shall then follow the wind in its own order of progress, which is the *reverse* of the order in which its successive changes are always presented to observers on this right hand side of the axis route, by the advance of the storm over the places of observation.

It is evident, therefore, that observers in the *right* side of a storm, in this hemisphere, have the changes of wind presented in a *backward* or reversed succession; while with those on the left side of the path the succession of changes is a forward one, coinciding with the order of the wind's rotative progress.

(3.) In accordance with the foregoing facts, we find that the observed changes in the wind's direction were most rapid or sudden in places nearest to the axis of the gale. On and near the axis path the southeasterly wind, first mentioned, was found to continue without much change of direction as the storm advanced, until the approach of the axis; when, commonly after an axial lull or remission, a change to the opposite quarter took place, more or less sudden, or rapid, and the wind then continued to blow from the northwestern quarter, till the close of the gale. See observations in Table II.

It may be seen that these several statements are but connected summaries of the observations which were made under different portions of the gale, during its progress.

Synopsis of the Observations.—To facilitate a satisfactory examination of this important question of rotation, I annex, in a brief and tabular form, the principal observations contained in the previous recitals; which are comprised in the three tables already referred to. The several cases are marked, in the first column, with the same numbers as before, and the order of progress is observed, except that the observations made within sixty miles of the axis line, comprising a belt of one hundred and twenty miles wide, along the center path of the storm, are comprised in Table II, while the remaining observations on the left side of the path are contained in Table I, and those from the right side in Table III. (For these tables see pp. 170—173.)

I also add the subjoined observations, obtained since the former recitals were printed.

4. Report from Capt. Brown, British ship *Gossypium*, reduced to civil time.—Sept. 30th, 1844, moderate breeze from N. N. E.; hauling northward, with hazy weather.

Oct. 1st, A. M., wind N. to N. N. W., gradually increasing; strong current carrying the ship to southward; lat. 20° 19′, lon. 84° 30′:—P. M., clear weather, wind N. W., increasing.

Oct. 2d, A. M., gale gradually freshening to double reefs; current one and a half knots to southward; lat. 20° 5′, lon. 85° 7′:—P. M., freshening from N. N. W., ship heading N. N. E.; (on larboard tack,) bar. 29·20; reduced sail to close reefed topsails, sent down top gallant yards; at midnight, in lat. 20° 46′, lon. 84° 37′, the gale increased rapidly to a hurricane, blowing from N. W.

Oct. 3d, A. M., hurricane with small rain and heavy sea, lying to on larboard tack with tarpaulins in mizen rigging, to keep the ship's head to the sea; wind veering from N. W. to W. and S. W.; barometer about 29 inches:—P. M., severe hurricane with rain; wind veering from S. W. to S. and S. E., from which last point it blew hardest and longest; at 11 P. M., the mainmast blew over the side.

Oct. 4th, A. M., severe hurricane; at 7 A. M., the foremast blew over the side; wind veering round from S. E. to E. and N. E.; barometer much as before:—P. M., hurricane with heavy rain; sea running very high; wind veering from N. E. to N., and inclining to moderate.

CHART VI.— *Showing the Daily Progress of the Cuba Hurricane with the Direction of Wind at the hour of 9 A.M. on the 5th 6th & 7th days of October, respectively 1844.*

The numbers show the places or vessels named in the recitals.

Engd by J.M. Atwood, N.Y.

Oct. 5th, A. M., gale continues; barometer slowly rising; wind veering from N. to N. W.; sea running high and ship laboring heavily:—P. M., strong gales from N. W. with a heavy cross sea.

Oct. 6th, A. M., winds moderate, from N. W.; lat. 20° 52′, lon. 84° 21′.

[Capt. B. gives this as an abstract of a statement drawn up at the time. It shows the same phases of the gale on the 4th and 5th as with the *Angola* (6) and *Openango* (7); while the previous report of the wind's veering "round the compass," during the gale, is also proved to be strictly correct. This statement shows, also, a perfect continuity in the double gale, at this locality, and possibly may indicate a detour in the axis-path of the second storm while in the Honduras sea, corresponding to the general system of progression which is seen on Chart 1. The complete revolution of the storm-wind with this ship, whose change of position was not very great, but whose track and winds differ much in direction from those of the *Norman* (19), is quite remarkable.—Capt. BROWN says, "the ship's *drift* was about two knots an hour, forming a kind of circle." The diameter of this circuit may have been 30 to 40 miles. Capt. B. was in the Barbadoes hurricane on the 10th of August, 1831, and thinks this storm quite as bad, while it was of much longer duration. He thinks the ship must have foundered had she been on the other tack.]

11*b*. Barque *Zaida*, Sept. 27th, was near Cape Cruz, S. side of Cuba, in lat. 20° 12′, winds E. by N. to N. E., and continued to vary between N. E. and N. W. till night of Sept. 30th, ending with fresh gales from N.—Oct. 1st, at 5 A. M., made Cape Antonio, [S. W. end of Cuba,] bearing N. N. W.; wind N. N. E., fresh breezes and clear; noon, lat. 22°, lon. 85° 30′; P. M. fresh gales N. N. E., hazy. 7 P. M. took in top gallant sails.—Oct. 2d, strong breezes N. by E. and pleasant; 6 A. M. N. E. by N.; 11 A. M. single reefed topsails; lat. obs. 22° 30′, lon. 85° 28′; P. M. commences strong from N. E., squally; 3 P. M. took in jib and spanker; 4 P. M. close reefed fore and main topsails and furled mainsail, reefed foresail; ends strong gales from N. N. E.—Oct. 3d, took in fore topsail; 4 A. M. furled foresail; sent down top gallant yards and hove to; gale still N. N. E., with a heavy cross sea from N. E. and N. N. W., ship laboring hard; up N. W., off N. N. W.; noon, lat. obs. 23° 28′, lon. 84° 14′; P. M. heavy gale from N. N. E. and cloudy; midnight, heavy squalls with rain.—Oct. 4th, 3 A. M. set reefed foresail; 4 A. M. gale N. E. by N., set close reefed fore topsail and mizen topsail; noon, lat. D. R. 23° 28′, lon. 83° 40′ [?]; P. M. gale N. E. by N., squally; 5 P. M. handed topsails and courses; 8 P. M. set fore courses.—Oct. 5th, 4 A. M. wind N. by W.; 7 A. M. N. N. W., squally, a heavy sea from N. E.; noon, lat. 23° 15′; P. M. fresh gales from N. N. W., cloudy, a heavy sea from S. E., N. E. and N. W.; 2 P. M. set fore topsail and mainsail; 4 P. M. wind N. N. W.; 8 P. M. N. W. by N.—Oct. 6th, A. M. wind N. W. by N., fresh breezes and fine weather; noon, lat. 23° 27′; P. M. winds N. N. W.; 8 P. M. N. N. E. [trades] light and variable.

Capt. CHAPMAN states that during the gale the Gulf Stream current, off Cuba, had become changed in its course, drifting the *Zaida* rapidly to the westward; so that on the morning of the 7th he found himself off Cape Cartouche, in lon. 86° 40′. On the 11th of October, at 3 P. M. he picked up the two survivors of the *Saratoga*, off Cape Florida, in lat. 25° 40′. [This position of the piece of wreck appears to show, also, the extraordinary check of the surface current of the Florida stream; for these men were drifted off the Bank as early as the 7th. See case 43, *ante*. The *Zaida* evidently had the double gale; the second superseding the first, early on the night of Oct. 3d.]

Capt. McGUIRE, of the *Rebecca* (20), states that the second gale, at Santa Cruz, began in the S. E. quarter, and went round by the S. to the westward, ending on the 5th. At 10 A. M. of 4th, had got to be very heavy, and fluctuated in tremendous squalls between S. S. W. and W. S. W. till 4 P. M., when it began to veer more westward, gradually abating.

35*b*. Capt. LESLIE, from St. Juan de Los Remedios, [N. side of Cuba, lat. 22° 37′, lon. 79° 40′,] reports that a very severe gale of wind occurred at that place on the 1st of October and continued until the 3d, commencing from N. to N. E., and ending at S. E., causing considerable damage to planters. *Charleston Patriot.*

45*c*. Barque *California*, Sept. 30th, lat. obs. 24° 51′, lon. 79° 34′; 2 P. M. fresh gales N. E. by E., cloudy, rough sea; 4 P. M. two reefed the topsails; 10 P. M. wind E. N. E.—

TABLE I.—*Left side of the Storm Path; Hurricane of Oct. 4th to 7th*, 1844.

These observations show the progressive occurrence of the storm-wind, first from the eastern and northeastern quarter, and successively changing or veering, more or less gradually, by the north, to the northwestern quarter, as the gale advanced in its course;—with the lowest state of the barometer noticed during the gale.

No.	Place, or Vessel.	Lat.	Lon.	Date and duration of gale.	Successive directions of storm-wind	Dist. from axis line.	When axis passed.	Bar. min.	Authorities and observers.	Remarks.
2.	*Maria L. Hill,*	19°51′	90°33′	Oct. 3d, to 5th,	'Norther,' ending at N.	380 miles.	3d—4th,		Logbook.	
4.	*Gossypium,* .	20 30	80 40	2d to 5th,	(4th,5th) E, NE, N, NW.	105 "	4th,	29 in.	Capt. BROWN's statement.	Severe hurricane; dismasted.
6.	*Angola,* . .	20 45	83 40	6 A. M. 4th to 5th,	ENE, to NNE, to NW.	69 "	4th, 9 P. M.	29 in.	Log: Capt. BELL.	Severe hur.; dismasted.
7.	*Openango,* .	21 15	83 30	morn. of 4th to 5th,	E, to NNE, to NNW, NW.	74 "	9·30 "		Capt. VOSE's statement.	Hurricane very severe.
11.	*Franklin,* .	22 40?	85 40?	4th to 5th,	N. easterly, northerly.	235 "	night,		Marine reports.	Driven 100 miles to S. W.
11*b*	*Zaida,* . . .	23 28	84	2d . 4th to 5th	NE b N, to N b W, NNW, NW b N.	180 "	"	**	Log: Capt. CHAPMAN,	Heavy gale.
12.	*H. Plantagenet,*	24 30?	83 40?	4th to 5th,	. NNE, . .	230 "	5th, 11 A. M.		Marine reports.	Gale strong from N. N. E.
29.	San Antonio,	22 55′	82 43′	5 P. M. 4th to 5th,	E, ENE, N, . .	93 "	7 " ?		Diario de la Habana.	Furious hurricane.
30.	Batabano, .	22 43	82 32	P. M. 4th to 5th,	NE, to NW.	76 "	3 "		do.	do.
31.	Guatao, . .	near	Hav.	noon 4th to P. M. 5th,	ENE, NE, NNE, . NW.	80 "	9·30 "		do.	Furious and destructive hur.
32.	Havana, . .	23 09	82 19	A. M. 4th to eve. 5th,	ESE, ENE, NE by E, N, NW.	85 "	10 "		Capt. FOSTER's journal.	Terrific hurricane.
36.	*Tasso,* . .	23 45?	82 20?	4th to eve. 5th,	ENE, NE, NNE, N, NNW, NW.	90 "	11 "		Capt. HOWES' statement.	Hurricane.
38.	Key West, .	24 27′	81 50′	A. M. 4th to noon 6th,	E, ENE, NE, N, NNW, W, NW.	118 "	2 P. M.	29·13	Rep. to Sur. Gen. LAWSON.	Destructive hurricane.
42.	Tampa Bay,	27 57	82 35	morn. 5th to P. M. 6th,	E, . NE, . .	300 "	night,	29·79	do.	W. coast of Florida.
45*a*	St. Augustine,	29 40	81 35	morn. 5th to noon 6th,	NE, N, NE, . . NW.	305 "	6th, 2 A. M.	29·82–	do.	Height of gale in night.
45*b*	*Demarara,* .	29 35	79 30	eve. 4th to eve. 6th,	ENE, NE b E, NNE, N, NNW, NW.	187 "	3 "		Log.	In Gulf Stream, off Florida.
45*c*	*California,* .	31 +	79 –	10 A.M. 5th to 10 P.M. 6th,	ENE, NE by E, N by E, NNW.	210 "	5·30 "		Log: Capt. MAYHEW.	do. off Darien, Ga.
72.	*Sterling,* . .	33 4	75 40	noon 5th to night of 6th,	NE, . N, NNW, NW.	230 to 150	9·30 "		Log.	do.; as also many others.
75.	Charleston, .	32 46	79 46	P. M. 5th to night of 6th,	E, . NNE, . NW, W.	335 "	7·30 "	29·80	Rep. to Surgeon Gen.	
76.	Cape Fear, .	33 54	78 1	night of 5th to night of 6th,	E, NE, NE, . . W.	300 "	10 "		do.	
77.	Beaufort, .	34 41	76 50	do. 5th to night of 6th,	. N, N, . .	270 "	noon,		do.	
81.	*Emeline,* . .	33 30	74 30?	5th to night of 6th,	NE, NNE, N, NNW.	117 "	do.	28·15†	Capt. SAWYER's statement.	Severe hurricane.
82.	*Republic,* . .	33 40	74	through 6th,	ENE, NE, NNE, N, NNW, NW.	148 "	0·30 P.M.		Log: Capt. GATES.	Gale very severe.
85.	*Wm. Nelson,*	35	74	" . 6th,	NE, to NW.	162 "	2 "		Marine Reports.	Severe gale.
86.	*Tioga,* . .	35 10	75	early 6th to morn. 7th,	NE, NNE, N, NNW, NW.	205 "	2 "		Log: Capt. HALLOCK.	Gale exceedingly heavy.
87.	*Cotton Plant,*	35	74	. 6th .	NE, NNE, N, NNW, NW.	162 "	2·30 "		Log: Capt. PRATT.	Ship dismasted.
88.	*B. F. Lamar,*	35 30	74 30′	early 6th to early 7th,	NE, NE b N, veering by N, .	200 "	2·45 "		Log: Capt. SANNERMAN.	Tremendous hurricane.
89.	*Clara,* . . .	34 40	73 30	. 6th .	. NNE, N, . .	120 "	2·30 "		Log.	Dismasted.
91.	*Rienzi,* . .	34 30	73 15	. 6th .	NE, E? NNE, N, NNW, NW.	100 "	2·30 "		Mar. Rep.; Capt. CLARK.	Tremendous gale.
97.	Fort Monroe,	37	76 19	night of 5th to night of 6th,	ENE, NE, . . NW.	345 "	3 "	29·82	Rep. to Sur. Gen.	

95.	*Montpelier*, .	35°50′	72°15′	4 A. M. 6th to morn. 7th,	NE, E? NNE, . NNW.	108 “	5 “		Log: Captain's statement.	Hove down; lost topmasts, &c
96.	*J. R. Gardner*,	36var.	73 20?	night of 5th to 6th,	NNE, NE, . N, NW.	140 “	5 “		Capt.'s PEDERSON & GOOD	Severe hurricane.
100.	*Orozimbo*, .	38 45	74 25	early 6th to noon 7th,	NE, NE, N, NNW.	320 “	7·30 “		Log: Capt. SERGEANT.	Heavy gale.
103.	*Orleans*, . .	39 30	73 30	6th to 7th,	NE, NNE, N, NNW.	350 “	8·30 “		Mates' statement.	Close reefed gale.
106.	New York, .	40 42	74 1	noon 6th to P. M. 7th,	NE, NNE, . N b W, NNW.	400 “	9·30 “	29·84–	Jour. of W. C. REDFIELD.	
111.	*Hottinguer*, .	39 40–	70to73	P. M. 6th to 7th,	NE, NNE, N, NNW.	265 “	10·30 “		Log.	Strong gale.
109.	New Haven,	41 18	72 57	noon 6th to P. M. 7th,	N b E, NE, . N b W, . NW.	359 “	11 “	29·72	Jour. of Col. CUTLER.	
112.	*Isabella*, . .	40 30	72	P. M. 6th to 7th,	NE, NNE, N, NNW, NW.	306 “	11 “		Marine Reports.	Very hard gale.
110.	New London,	41 20	72 8	P. M. 6th to P. M. 7th,	NE, . N, . W.	336 “	11·40 “		Rep. to Surgeon Gen.	Heavy rain and high wind.
114.	Newport, .	41 28	71 23	P. M. 6th to P. M. 7th,	NE, . N, . NW.	324 “	12 “	29·79	do.	
118.	Nantucket, .	41 15	70 6	P. M. 6th to P. M. 7th,	E, NE, . N, NNW.	260 “	7th, 0·30 A. M.	29·50–	Jour. of WM. MITCHELL.	Gale extremely heavy.
120.	(a) *Unicorn*, .	39 47	68 56	P. M. 6th to eve. 7th,	ENE, NE, N, NNW, NW.	152 “	0·30 “		Log.	Severe hur.; lost sails, &c.
124.	*Nath. Hooper*,	40 20	68 20	P. M. 6th to eve. 7th,	NE, . N, NNW, NW.	152 “	1 “	28.60†	Log: Capt. CHURCHILL.	do.
121.	*Sarah & Arsilia*,	40	66var.	1 P. M. 6th to end of 7th,	ESE, ENE, NE, NNE, N, NW.	103 to 50	3·30 “		Log: Mates' statement.	do.
123.	*Courier*,‡ . .	39 30	67var.	2 P. M. 6th to eve. 7th,	ENE, NE, NNE, N, NW.	80 to 40	2 “		Log.	do.
122.	*Zurich*, . .	40–	67var.	P. M. 6th to P. M. 7th,	E, NE, N, NNW, NW.	140 to 115	1·30 “		Log.	Heavy gale.
126.	Watertown Ars.	41 21	71 12	P. M. 6th to P. M. 7th,	NE, NE, NW.	352 “	1·30 “	29·79§	Rep. to Sur. Gen.	
127.	Portsmouth, .	43 03	70 43	P. M. 6th to eve. 7th,	E, NE, . N, .	364 “	2·30 “		do.	
128.	Hanover, . .	43 41	72 22	P. M. 6th to night of 7th,	N, N, N.	460 “	2·30 “		Jour. of Prof. YOUNG.	
133.	*Roscius*, . .	41 10	65 50	P. M. 6th to 7th,	ENE, . N, NNW, NW.	85+ “	1·30 “	28·25*	Capt. COLLIN's statement.	
134.	*Rochester*, .	42	67	eve. 6th to 7th,	. NE, . . .	182 “	4·30 “		Marine Reports.	Severe gale.
135.	Portland, . .	43 30	70 21	eve. 6th to 7th,	SE? . N, NW, N.	368 “	4·30 “	29·73	Rep. to Sur. Gen.	
136.	Yarmouth, .	43 51	66 5	eve. 6th to night of 7th,	NE, . N, NW.	225 “	10 “		Marine Reports.	Heavy gale.
137.	*St. Petersburg*,	43 5	65 14	6th to 7th,	E, ...	152 “	9·45 “		Marine Reports.	Severe gale; lost topmasts, &c.
138.	Eastport, . .	44 53	67	end of 6th to night of 7th,	. NE, N, NW.	310 “	10 “		Rep. to Sur. Gen.	
139.	Holton, . .	46 5	67 40	“ 6th to “ 7th,	. NE, NW, .	390 “	10·30 “		do.	
140.	Fort Kent, .	47	68 20	“ 6th to “ 7th,	. NE, N, N.	460 “	11·15 “		do.	
141.	Halifax, . .	44 36	63 28	2 A. M. 7th to A. M. 8th,	NE, ENE, NE'terly, N, . NW.	168 “	11·30 “	29·23	Log H. M. ship *Illustrious*.	Ad. Sir C. ADAM, thro' Col. REID
142.	*Scylla*, . .	44 21	63	end of 6th to noon 8th,	E, ENE, NE, NNE, NNW, NW.	88 to 132	11·30 “	28·90	Log H. M. ship *Scylla*.	do.
143.	Cape Canso, .	45 20	60 58	early 7th to 8th,	SE, . to N. and NW.	98 “	2·45 P. M.		Master of Schr. *Actress*.	
144.	*Pique*, . . .	45 33	61 18	early 7th to 10 A. M. 8th,	SE b E, E b N, NNE, N, NNW, NW.	130 “	3 “	29·19	Log H. M. ship *Pique*.	do.

Ships 121 and 123 were in the Gulf Stream, bound eastward; longitude uncertain. Ships 111, 122, 133, 144, with probably 137, were running rapidly westward, as was the case in some degree with several others.

† In the cases of the barometrical entries having this mark, † the several barometers have been compared with my own at New York and the corrections for index errors are here made. This remark applies to all the tables. ** Barometer said to have varied an inch.

‡ The course and drift of the Courier (123) should be more eastward than is represented in the storm charts.

§ Barometer as observed at Boston, by R. T. PAINE, Esq. * Barometer corrected by verbal information.

Table II.—*Center Path of the Hurricane of Oct. 4th to 7th,* 1844.

These consecutive observations show the progressive storm-wind, first from the southeastern quarter of the horizon, which, on the passing of the gale's axis, changed rapidly or suddenly to the western or northwestern quarter;—with the lowest state of the barometer observed.

No.	Place, or Vessel.	Lat. N.	Lon.	Date and duration of gale.	Successive directions of storm-wind.	Dist. from axis line.	When axis passed.	Bar. min.	Authorities and observers.	Remarks.
5.	*Majestic*, . .	20°30′	83°10′	Oct. 4th and 5th,	ESE, remission, NW, WNW.	30 miles L.	4th, 3 P.M. ?		Honduras Observer.	Totally dismasted.
34.	Matanzas, . .	23 3	81 41	10 P.M. 4th to P.M. 5th,	E, NE, variable, W.	48 " L.	5th, 11 A.M.	28 in.	Diario de la Habana.	Violent hurricane.
35.	Cardenas, . .	23 2	81 15	eve. of 4th to eve. 5th,	E, . . .	27 " L.	11 "		do.	Vio. hur. fr. 11·30 P.M. 4th; 24 hs.
37.	*Columbo*, . .	24 15	80 30	11 P.M. 4th to 2 A.M. 6th,	SE, ESE, lull, sud. to WNW,§ NW.	30 " ? L.	4·30 P.M.		Mar. Rep.: Mates' stat.	Hur. 30 hs., shifted sud. to N.W.
50.	*Reform*, . .	27 15	77	P.M. 5th to 11 A.M. 6th,	SE, sud. lull, SW, W. .	L. near axis.	6th, 2 A.M.		Log: Mates' statement.	Hr. S.E, sud. lull, shift to west'd.
51.	*Star Republic*,	27 25	77 10	P.M. 5th to A.M. 6th,	ESE, sud. lull, W. .	L. do.	2·30 "	28·24†	Log: Capt. Hendley.	Hr. E.S.E, lull 30 m. then fu. fr. W.
52.	*Josephine*, .	27 40?	77 6 ?	P.M. 5th to A.M. 6th,	SE, sud. lull, NW.	near do.	3 "		Mar. Rep. A. Thomson.	Hove on b'm ends; lost spars.
70.	*Leonora*, . .	32 40	74 15	P.M. 5th to A.M. 6th,	ESE, veered sud. to N, NNW, NW.	L. near do.	9 "		Log: Capt. Collins.	Totally dismasted.
71.	*Arkansaw*, .	31 30	75	P.M. 5th to P.M. 6th,	ESE, lull, sud. to WNW.	55 m. L.	9·30 "		Log: Capt. Bunker.	Dismasted. Furious hur.
59.	*Charlotte*, . .	32	73	night of 5th to end of 6th,	SE, NW. .	15 " R.	11·30 "		Marine reports.	Lost all but lower masts.
61.	*Victoria*, . .	32	72 30	" 6th "	SE, rapidly S, to westward.	38 " R.	noon,		Stat. fr. Capt. Bunce.	Dismasted. Furious hur.
63.	*Potomac*, . .	32 30	71 30	" 6th "	E, ESE, .	60 " R.	1·30 P.M.		Marine reports.	Dismasted; close of g. not rep.
146.	*J. N. Cooper*,	35 50	69 ?	4 A.M. 6th "	SE by E, SSE, SSW, SW, NW.	25 " ? R.	7·15 "		Capt. Varney's stat.	Furious hurricane.
105.	*St. Pierre*, .	37 var.	69 36	1 P.M. 6th, to 7th,	ESE, SE, NW.	56 " L.	8·30 "		Marine reports.	Dismasted.
148.	*Wakulla*, . .	36 40	67 30	4 P.M. 6th, gale 14 hours,	SSE, S, sud. to NW.	148 to 20 R.	10 " ?	27·75†	Log: Capt. Mulford.	Hove on b'm ends; lost spars.
151.	*Elvira*, . .	38 10	66 30	A.M. 6th to noon 7th,	. S, SSW, .	150 to 20 R.	7th, 0·30 A.M.		Marine reports.	Tremendous hurricane.
152.	*Nye*, . . .	38 58	65	P.M. 6th to 7th,	SE, .	47+ R.	2·30 "		Master's protest. }	From Wm. Mitchell; both
153.	*Mt. Vernon*, .	39	66	P.M. 6th to 7th,	SE, sud. by S, and SW to W.	6+ R.	2 " ?		Master's protest. }	ships disabled & returned to pt.
129.	*Mediator*,* .	40 25	64 20	P.M. 6th to 7th,	NE, ESE, SE, SSW, W, NW.	40 L. to 98 R.	4 " ?	28·28†	Log: Capt. Chadwick.	Crossed axis line during gale.
130.	*St. Nicholas*,*	40 15	65 10	2 P.M. 6th to P.M. 7th,	ENE, E, SE, lull, sud. to NW.	25 L. to 31 R.	3·20 "	28·37†	Log: Capt. Pell.	do.
131.	*Cambridge*,* .	40 30	64 30	5 P.M. 6th to A.M. 7th,	ENE, ESE, SSE—SSW, WSW, W.	40 L. to 90 R.	3·45 "		Log: Capt. Barstow.	do.
132.	*Mentor*, . .	40 30	65	2 P.M. 6th to eve. 7th,	SE, .	24 m. L.	4·30 "		Marine reports.	Dismasted and abandoned.
157.	*Hellespont*, .	40	63 30	eve. of 6th to 7th,	hur. SSE, veering SW, .	57 " R.	5 "	28·50‡	Bermuda Gazette.	Dismasted in the hurricane.
159.	*Memphis*, . .	43 6	60	eve. of 6th, to P.M. 7th,	ESE, SE, SW, WNW.	75 to 34 R.	0.40 P.M.		Log: Capt. Coffin.	Violent gale.
160.	*Europe*, . .	44 19	58	early 7th to morn. 8th,	SSE, S, SE, WSW to WNW.	60 to 45 R.	3·30 "	low,	Log: Capt. Furber.	Heavy gale.
145.	*Normal*, . .	48 45	53 45	7th to 8th,	ESE, [E. true] to N. and NW. .	40 m. L.	8th, 8 A.M. ?		From a seaman of N. F.	Damaged sails.

* These three ships were in the Gulf Stream bound eastward, and crossed the line pursued by the axis during the height of the gale; the *Mediator* and *Cambridge* apparently in front of the axis, and the *St. Nicholas* nearly intersecting it. Vessels 148 and 151 were running into the gale. The winds for 146 seem better suited to a lower latitude or longitude.

§ Erroneously printed N. N. W. in the recitals. † Index error of barometer corrected. ‡ Sympiesometer.

CHART VII. _ *Showing the Daily Progress of the Cuba Hurricane with the Direction of Wind at the hour of 3 P.M. on the 5th 6th & 7th days of October, respectively 1844.*

The numbers show the places or vessels named in the recitals.

Engd by J. M. Atwood. N.Y.

Table III.—*Right side of the Storm Path; Hurricane of Oct. 4th to 7th*, 1844.

These consecutive observations show the progressive appearance of the storm-wind, first from the southeastern quarter, and its successive changes or veering, by the south, to the western quarter;—with the lowest state of barometer noticed during the gale.

No.	Place, or Vessel.	Lat. N.	Lon.	Date and duration of gale.	Successive directions of storm-wind.	Dist. from axis line.	When axis passed.	Bar. min.	Authorities and observers.	Remarks.
13.	*Trojan*, . .	19°5′	80°50′	noon 4th to A. M. 5th,	SE, SSE, S, SSW, SW.	145 miles.	4th, 8 P. M.		Log: Capt. Davis.	Heavy gale.
15.	*Eastern Star*,	18 15	78 25	night of 3d to eve. 5th,	SSE, veering by S, to SW. .	315 "	10 " ?		Log: Captain's statement.	Near west end of Jamaica.
17.	Montego Bay,	18 28	77 57	4th to 5th,	. S, . . .	330 "	—		Nautical Magazine.	Destructive swell.
19.	*Norman*, . .	19	82var.	night of 3d to night of 5th,	SSE, S, SW, WSW.	200 to 100	4 " ?	28·50†	Log.	Severe hurricane.
20.	*Rebecca*, . .	20 44	78	4th *to* 5th,	SSE, S, SSW, WSW, W.	225 "	5th, 3 A. M.		Log: Mates' statement.	Severe gale.
25.	Bay of Gonaives	19 38	73	4th to 5th,	. S, or SW.'erly, .	550 "	2 P.M.?		Marine reports.	Vessels driven on shore.
53.	Nassau, . .	25 4	77 18	5th to 6th,	SE, SSE, S, SSW, SW, .	90 "	9·30 "		Bermuda Gazette.	
55.	*Berlin*, . .	26	75	P. M. 5th to 6th,	SE, veering round to SW, .	175 "	6th, 2 A. M.		Marine reports.	Hurricane.
56.	*Lagrange*, .	26 30	75 30	" 5th to 6th,	SE, SSE, S, . .	127 "	2·30 "		do.	do.
57.	*Herald*, . .	30	73 30	eve. 5th to 6th,	SE, ...	75 "	8·30 "		do.	Heavy gale; dismasted.
58.	*Sea Lion*, . .	28	70 ?	night of 5th to 6th,	SE, veering round to W.	330 ? "	8·45 "		do.	do. lost sails, &c.
62.	*Pioneer*, . .	30 30	69 52	morn. 6th *to* midnight.	S, SSW, SW, WSW.	275 *to* 213	1 P.M.?	29·45	Log: *from navy depart.*	Through Lt. M. F. Maury.
65.	*Brothers*, . .	32	70 22	through 6th,	SE, . S, SW to WNW.	140 "	1·45 "		Logbook.	Severe hur.; dismasted.
64.	*St. Cloud*, .	32 30	70 25	end of 5th to night 6th,	ENE, SE, S b E, SSW, SW b W.	95 "	2 "	28·40	St. from Capt. Emerson.	Hurricane.
66.	*H. W. Tyler*,	31 30	68	. 6th, .	. S, . . .	265 "	3 "		Mar. rep.: Capt. Clark.	Severe gale; lost sails, &c.
68.	*Falcon*, . .	32 50	65 40	6th to early 7th,	SSE, veering to S, SW, and W.	300 "	7 "		Ber. Gaz.: Capt. Pitt.	Lying to eight hours.
69.	Bermuda, . .	32 15	64 40	6th to " 7th,	SSE, S, SW, .	375 "	7 "	29·86	Serg. Irwin's rep., sig. sta.	
149.	*St. Lawrence*,	36 50	67 2	6th to " 7th,	. . . . .	60 "	10·15 "		Marine reports.	Hurricane; dismasted.
154.	*Lowell*, . .	35	60var.	A. M. 6th to noon 7th,	SE, S, SSW, W, WNW.	380 to 460	7th, 1 A. M.		Log: Mate's statement.	Gale.
155.	*Wm. Engs*, .	37 10	60 29	8 P. M. 6th to night of 7th,	SW, veering to WNW.	316 "	3.30 "		Log: Capt. Coe's stat.	Heavy gale.
156.	*Charleston*, .	37 50	60	5 P. M. 6th to end of 7th,	SW, SW by S, WSW, W, NW.	380 to 304	6 "	28·10?	Log: Capt. Catermole.	do.
158.	*Sheridan*, .	43	57var.	night of 6th to noon 8th,	E, . WSW, SW, W, WNW.	75 to 270	3·30 P.M.		Log: Capt. De Peyster.	Strong gale.
164.	*Prince Albert*,	45 20	48	P. M. 7th to 8th,	E, SSE, W by S, W by N, WNW.	325 "	8th, early,		Log: Capt. Sebor.	do.
161.	St. Johns, .	47 33	52 25	A. M. 7th to 8th,	E.'erly, W by S, W by N, WNW.	85? "	8th, A.M.?	29·44–	Log: J. Templeman.	
162.	*Independence*,	47 26	45 37	night of 7th to 9th,	E.'erly, . . NW, WNW.	282 "	noon ?		Log: Capt. Nye's jour.	Strong gale.
163.	*Adirondack*, .	46	43 20	early 8th to 9th,	NE, E, . . NW b W, var., WNW.	415 "	" ?		Logbook,	do.

No. 19 was running fast to westward, into the gale; Nos. 154 and 158 were running rapidly eastward, the latter in the Gulf Stream.

† Corrected for index error of the barometer.

Oct. 1st, gale continues; 1 P. M. took in foresail; 5 A. M. close reefed topsails and set foresail: lat. obs. 26° 6′, lon. 79° 35′, in Florida channel: P. M. heavy gale and squally with some rain.—Oct. 2d, A. M. moderate; lat. 27° 2′, lon. 79° 45′; P. M. heavy squalls of rain and rough sea; 4 P. M. furled mainsail.—Oct. 3d, gale abated, and good weather through the 4th.—Oct. 5th, 6 A. M. N. E., fresh; 10 A. M. E. N. E., freshening, cloudy: lat. D. R. 30° 49′, lon. 79° 16′: 2 P. M. E. N. E., cloudy, took in top gallant sails; 6 P. M. N. E. by E., single reefed; 8 P. M. took in mainsail, jib and spanker; 10 P. M. N. E., gale increasing, close reefed.—Oct. 6th, 2 A. M. E. by N., severe gale, hove to; 4 A. M. up E. N. E, off E. S. E.: [showing the wind at about N. N. E.: at 6 A. M. was about 220 miles from axis line of the gale]: 10 A. M. up N. E. by N., off E. N. E., [wind N. by W.?] heavy gale; noon, lat. obs. 31° 13′, lon. 78° 51′; 2 P. M. N. N. W., more moderate, set foresail; 4 P. M. out one reef from topsails and courses; at 10 A. M. gale had ceased, and light winds came from the eastward.

The logs of the *Demarara* and *California*, with the other accounts, will enable us to trace the first gale more perfectly, in its progress from Cuba.

65. Brig *Brothers*, for New York, Oct. 5th, winds N. W. to S. W., set top gallant sails; noon, lat. 30° 48′, wind W. N. W., light, cloudy; 6 P. M. calm and much rain; 8 P. M. light breeze from N. E.; midnight, moderate breeze from S. E.

Oct. 6th, begins wind S. E., and at 8 A. M. had increased to a strong gale, close reefed the topsails and furled the courses and fore topsail; at 10 A. M. hove to, blowing very heavy, in lat. 32°, lon. 70° 22′; at 11 A. M. blowing a hurricane from S. E., cut away the main topmast and also the deck load, the brig nearly on her beam ends; noon, still increasing; all hands at the pumps, blowing a complete hurricane, which at 2 P. M. had shifted to S. W., making a tremendous sea and heaving the brig on her beam ends; cut away the foremast; at 4 P. M. gale abating and a tremendous sea; at 8 P. M. wind had veered to W. N. W.—Oct. 7th, light winds from W. N. W. to N. W. and a heavy sea; noon, lat. 32° 19′. [Logbook.]

97*b*. Dr. JOHN AUGUSTINE SMITH, who was at a point in Virginia about 60 miles W. N. W. from Fort Monroe, informs me that on the 6th October the storm exhibited there the character of an ordinary northeaster.

144. H. M. S. *Pique*, river St. Lawrence, first Cuba gale:—Oct. 3d, A. M. winds southeasterly, strength 2 to 4, weather b c, c; 9 A. M. bar. 30·24 in.; noon, 30·20; lat. 49° 30′, [lon. 66° 26′,] St. Ann's River S. by W. ½ W. 22 miles. P. M. winds southeasterly, light; 8 P. M. bar. 30·19.—Oct. 4th, begins calm; 4 A. M. S. E. 4, c; 8 A. M. 5, m g; 9 A. M. bar. 30·18; 10 A. M. wind S. S. E., 4 b c; noon, S. S. E., 5; bar. 30·17; lat. 49° 41′, [lon. 64° 42′, off the W. end of Anticosti.] At 1 P. M. wind S. E., 6; reefed topsails and spanker, down royal yards; 2 P. M. split jib and set fore staysail, bar. 30·12; 3 P. M. 7 b c q; 4 P. M. two reefs in topsails; 6 P. M. wind S. E., 5, c; 8 P. M. 4, c, bar. 30·08, set top gallant sails; 10 P. M. S. E. by E., 5, c.—Oct. 5th, 1 A. M. S. E. by E., 5, c; 2 A. M. 6, c q; in third reef of main topsail; 4 A. M. 7, c q r; set reefed foresail, close reefed and furled fore and mizen topsails, down top gallant yards and housed the masts; 5 A. M. wind E. S. E., 7; 6 A. M. 8; 8 A. M. S. E., 7, c r q, bar. 29·44; 9 A. M. E. S. E., 6, o q d; 10 A. M. 5, bar. 29·36; 11 A. M. S. E. by S., 5; noon, S. E. by E., 4, o q r, bar. 29·31; lat. 49° 35′, [lon. 64° 35′,] off W. end of Anticosti:—1 P. M. wind S. E., 2; up top gallant masts and yards and made sail; 2 P. M. bar. 29·28; 3 P. M. wind S. by E., 3; 4 P. M. 3 bar. 29.23; 6 P. M. S. S. W. 4, c q, *bar.* 29·16; in second reef of topsails and driver; 7 P. M. set top gallant sails; 8 P. M. wind N. W. b N., 2, o c, bar. 29·19; 11 P. M. wind W. S. W., 3, c r; midnight N. W., 4, b m. [This shows the axial center of the first gale to have passed near the *Pique*, with indications of an extensive central lull or remission. For the continuation of this log see recital 144, as previously given.*]

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* This further extract has been obtained through the favor of Col. Reid.

THE PARADOX OF REVOLVING WINDS.—It is still possible that some persons may not be able to understand, clearly, how the wind in a progressive storm which revolves in one constant direction around its axis, can at the same time be found to veer in opposite directions, on the opposite sides of the axis line, as is seen in Tables I. and III. respectively. But this fact, of which an explanation has already been attempted, may be seen to be a necessary result of the law of rotation, as manifested in all revolving bodies; and failing to understand this law, no one can intelligently pursue the inquiry.

Let a circular disk of stiff paper be written upon in one or more circular lines, around its center, either in a concentric or vorticose form; then put this disk in rotation upon its center, and pass two fingers across it in parallel directions, one on each side of the axis, and it will be found that one finger passes the circular writing in the order in which the words are written, while on the opposite side of the axis the other finger, though moving in the same direction, will pass over the writing in the opposite or *reverse* order to that in which the words are written. Of course this will equally follow in case the revolving disk be advanced under the fingers, as when the fingers are advanced over the disk.

The two opposite orders of succession in which the letters are thus presented on the revolving disk, are equivalent to those of the winds which are presented to separate observers on the two opposite sides of the storm. This then being the law of rotation, it follows, that if the general course pursued by a storm be known, two rough observations of the order of changes in the wind, one on each side of its axis path, may be quite sufficient to determine its revolving character; provided that the early and later winds near the axis path have blown transversely to the course of progression; to determine which, even the same observations may suffice.

PROOF OF ROTATION AFFORDED BY DIRECT INSPECTION.—Perhaps it may be deemed that the rotation of great storms, as a question of fact, resting on observations, was as distinctly determined in the case of the American storm of Sept. 3d, 1821, or that of August 16th, 1830, as by the great case which is now before us.* But the latter affords data of a more precise and

* The jointly revolving and progressive movement of the entire storm which visited Connecticut on the 3d day of September, 1821, was distinctly ascertained in

extended character than is often obtained, and is, therefore, well suited to remove doubts from those who are unaccustomed to a course of specific inquiries. To such, the proofs of rotation afforded by a direct inspection of simultaneous observations, when plotted on a map, may be more satisfactory. This case is also a favorable one for the study of navigators; who must necessarily become acquainted with the progressive character and determinate changes of revolving gales, or submit to the inevitable evils of neglecting such knowledge.

For these objects, it proves favorable that the unusually rapid progress of this hurricane was such as to enable us to show, on the same chart, a separate development of the daily advance of the storm, and the simultaneous direction of its wind on all sides at the same hour, on successive days. This is first done on Chart IV, where the place of the storm at noon of each day, as approximately determined, is denoted by separate sets of concentric

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the course of that month. This unexpected result, as made apparent also in other storms, was made known without reserve to the writer's friends and others, but was not published in any Journal till April of 1831, when the westerly progression in low latitudes was also distinctly shown. It was not till seven years later (1838) that I became acquainted with the suggestions and opinions of Col. CAPPER, and with the particular views and elucidations published by Prof. DOVE in his paper on Barometric Minima, found in POGGENDORF's Annalen, 1828.

To the valuable investigations of Prof. DOVE, I am anxious to do full justice. But I have found some degree of difficulty in ascertaining the *extent* in which his elucidations and views of certain storm-winds, as exhibited in his article above mentioned, coincided with the main results of my separate inquiries; a difficulty which perhaps may be owing chiefly to my want of acquaintance with the German language and with the modes of illustration used at that time by this distinguished inquirer.

It is evident that the integral rotation of the trade and general winds in performing their great circuits, both in the northern and southern hemispheres, is in the direction which is opposite and reverse to that which is uniformly found in the revolving storms or eddies which are carried forward in these general currents of rotation. Thus the great rotative and geographical course of the latter, in the northern hemisphere, is successively from S., W., N., E., S.; while the rotation of a storm, borne along by this current, proceeds successively from S., E., N., W., S.; being the opposite direction of rotation. At the same time, the constant *tendency* of the difference of velocity in the earth's rotation, in different latitudes, is to favor or produce, locally, such *leftwise* movements of rotation as the storms exhibit in the northern hemisphere; at least in those parts of the general currents which have a progression towards the polar latitudes, and as apart from the concurrent influences of rotation which may exist in greater or less force in various regions. This leftwise tendency of rotation in storms, may be counteracted in the opposite parts of the great circuit, in returning towards the equator.

lines; and the direction of wind at that hour, so far as determined by direct or approximate observation, is indicated by the several wind-arrows.

To avoid any chances of error, the like delineations are also made for different periods of the day, at intervals of three hours each; which will be found on Charts V to X, inclusive. These are drawn on the same scale and ground work as Chart IV, and are severally derived in like manner from the observations. This will afford opportunity for mariners and others to contemplate the progressive changes which are produced, on different sides, by the advance of the revolving storm.

This manner of plotting the simultaneous observations, for inspection, was adopted in my notice of the New England storm of Dec. 15th, 1839; but without the advantages of a successive exhibition at daily intervals, which the present case affords.*

If any inquirer, who is careful to apprehend rightly the several accounts relating to the wind's direction, and the true periods of the several successive changes there mentioned, shall conclude that any of the wind-arrows found on these Charts are without sufficient authority, he has only to cancel the same and rely on those others which he may deem to be more truly determinate; and it will easily be seen whether the proof of a general rotation of the storm-wind is at all invalidated by such omissions.

Vortical Inclination of the Storm-Wind.—By this is meant some degree of involution from a true circular course.† In the New England storm above referred to, this convergence of the surface winds appeared equal to an average of about six degrees from a circle. In the present case, such inclination seems more or less apparent in the arrows on the storm figures of the several charts; where the concentrical circles afford us means for a just comparison of the general course of wind which is approximately shown by the several observations. In some *quadrants* of the storm, as thus exhibited, the average inward convergence, at certain periods, may amount to two or more points of the compass. This may possibly be due in part, to the trending of the coast, and also more probably to the very prevalent habit of re-

* This Journal, vol. xlii, p. 117. Trans. Am. Phil. Soc., vol. viii, part i, p. 81.
† *Ante*, vol. i, Second Series, p. 14.

ferring nearly all northeasterly and northwesterly winds to the northeast and northwest points specifically.

Perhaps we may estimate the average of the vorticose convergence, as observed in the entire storm for three successive days, at from five to ten degrees,—out of the *ninety* degrees which would be requisite for a congeries of centripetal or center-blowing winds. This rough estimate of the degree of involution is founded only on a bird's eye view of the plotted observations. But however estimated, this involution seems to afford a measure of the air and vapor which finds its way to a higher elevation by means of the vortical movement in the body of the storm. It probably finds its limit at various and unequal distances from the general center of revolution, and at a very moderate elevation from the earth's surface; according to the existing conditions and activity of the storm. That it does not commonly extend over the entire area of central inactivity, which is found at the earth's surface, may be inferred from the general absence of rain, and sometimes even of clouds, in this axial area of the storm.

Observed Direction of the Storm-Scuds.—It may be of some importance to notice, that, so far as can be settled by my own observations of the storms of the United States, the directions of the *scuds* which fly in the most active portion of the gale, intermediately between the earth's surface and the great stratus cloud which overlies the gale, and below any regular cloud stratum, *have generally no inward inclination* in their course, as regards the gale's axis; but rather the contrary. By careful observations, these scuds are commonly found to fly from directions which are from half a point to one or two points *more to the right*, on the compass card, than the direction of the storm-wind at the earth's surface. The elevation of these floating scuds is also comparatively small; and in the rainy portions of the gale, appears chiefly comprised in a range from five hundred to twenty-five hundred feet above the surface.

These results are nearly alike common, whether the observer be placed on the axis path of the storm, or on the right or left side of this path; and are found in a large portion of the true storm-winds, from the north round by the east to the southwest. If there are some apparent exceptions, arising from irregularities in the attending or overlying winds, or from invisibility of scuds and the presentation of other cloud-currents, it is believed they will not invalidate the general results of the observations.*

In the case before us, I can find no strict observations directed to this point, except my own; which, on the afternoon of the 6th, show the wind from N. N. E. and the storm-scud from N. E., being the not unusual difference.

Accelerated Rotation in the Body of the Storm.—We find in this case, as in other storms, a greatly accelerated velocity of rotation in the wind as we proceed from the exterior limits towards the axis of the gale, till we reach that interior portion where the destructive force of a hurricane was exhibited. This is in accordance with the universal law of vortical revolution, which seems no other than the law of *equal areas in equal times.* Like the vortical involution, this acceleration finds its principal limit externally to the region of central inactivity in a storm; and, in some storms and localities, at a very great distance from the geographical center of revolution; the active portion of the

* From the observations found in my journal I select only the following. The several columns show, successively, the dates,—observed direction of the storm-wind at the surface,—the simultaneous direction of the storm-scuds,—and lastly, the mean range of the barometer in the storm, reckoned from its next previous and subsequent maximum.

Dates.	Winds.	Scuds.	Range, inches.	Dates.	Winds.	Scuds.	Range, inches.
1832, Nov. 19,	SSW.	SW.	0·80	1837, June 2,	S.	SW.	0·78
" 22,	NNE.	NNE. brisk,	0·53	" 7,	ENE.	E.	"
" 23,	WSW.	W.	"	" 18,	N.	NNE.	0·52
Dec. 15,	NE.	ENE.	0·29	1838, March 3,	NE.	ENE.	
1833, Jan. 13,	NE. by E.	ENE.	0·86	June 23,	SE.	SSE.	0·29
" "	NNE.	NE.	"	Sept. 6,	ENE.	E. by N.	
Feb. 7,	NW. by N.	NNW.	0·22	Oct. 19,	ESE.	SE.	0·67
" 13,	ENE.	E.	0·70	1839, Jan. 15,	NE. b E.	ENE.	
" 19,	SSW.	WSW.	0·57	June 3,	ESE.	SE.	
Oct. 12,	ESE.	SE.	0·90	" 4,	E. by N.	ESE.	
1835, March 22,	NNE.	NE.	1·02	" 18,	S.	SW.	0·20
May 15,	N.	NNE.	0·29	Aug. 30,	NNE.	NE.	0·35
1836, Jan. 10,	N.	NNE.	1·01	Nov. 5,	E.	ESE.	0·71
April 22,	NW.	NNW.	0·59	Dec. 4,	NNE.	NE. b E.	0·30
May 3,	SSW.	WSW.	0·58	" 16,	NNW.	N·	0·75
" 12,	SE.	SSE.	0·70	" 22,	ENE.	E.	1·01
" 30,	NE. by E.	ENE.		1840, April 23,	SSW.	SW.	0·40
June 2,	NE. by E.	E. by N.		May 9,	NE.	ENE.	0·32
" 4,	NE. by E.	ENE.		" 21,	NE.	ENE.	0·64
" 21,	NE.	ENE.	0·29	" 24,	ESE.	SE.	"
July 13,	NE.	ENE.	0·25	1841, May 30,	NE.	ENE.	
" 22,	N. & NNE.	NE.	0·54	June 23,	ESE.	SE.	0·24
Oct. 4,	NE.	ENE.	0·75	Aug. 29,	NE.	ENE.	
Nov. 20,	ESE.	SSE.	0·56	Oct. 4,	N. ½ W.	N. by E.	0·36
Dec. 21,	SSE.	S.	1·00	Nov. 19,	NE.	ENE.	0·34
1837, Jan. 21,	NE. by E.	NE.	1·25	1842, Feb. 3,	SSW.	SW.	0·89
Feb. 28,	NW.	NNW.	1·18	" 16,	SE. b S.	SSE.	1·43
March 13,	S.	SSW.	0·70	" 26,	ENE.	E.	
" 22,	NE. by E.	ENE.	0·40	May 20,	NE. b N.	ENE.	
April 26,	NNW.	N. by W.	0·37	Dec. 13,	NE. b E.	ENE.	0·61

storm having, in these cases, somewhat the form of an annular disk, of great internal diameter.

THE AXIAL REGION.—The lull or abatement of the wind's force in the center of the hurricane or gale, is a marked feature of this and other active storms. The superficial extent of this area of inactivity seems variable and uncertain. It is commonly found to be greatly extended as the storm advances into the higher latitudes; where, not unfrequently, it seems to become merged with a general remission in the force of the easterly winds which belong to the anterior portion of the gale; as may be seen in the more advanced stages of this storm, (reports 161 to 165,) and perhaps may be shown more fully hereafter.*

This axial lull and the shift of wind which immediately follows it, must be distinguished from sudden but more partial changes in the wind's direction at greater distances from the center, which may result from mere oscillatory movements in the advancing axis or from the concurrent force of adjacent winds, or other causes, and which may be communicated over large portions of the most active part of the gale. This unequable shifting or veering is strongly exemplified in the reports from the *Roscius* (133) and *Wakulla* (148), concurrently on different sides of the axis, at nearly the same time; as if the higher portion of the storm had measurably overrun the lower, in its progression, and suddenly taken its place at the surface. Some lesser degrees of this unequal veering, and sometimes of a fluctuating or oscillatory character, may be seen in other parts of the storm.†

* It might be inquired how far the direct *momentum* of the violent and onward wind in the right hand side of the storm path may favor its partial or complete *oversliding* of the more sluggish atmosphere on the earth's surface, in passing to the front of the storm, in the higher latitudes; thus approximating more nearly to a true plane of rotation. If any possible weight can be allowed to this suggestion, which, to a limited extent, is accordant with an idea of the late Prof. LESLIE, it may perhaps serve in explaining the comparative inactivity of the easterly winds in this and other storms of the Atlantic, in the higher latitudes, particularly in the colder portions of the year, when, often the principal strength and duration of the gales are found mainly in the westerly winds of the posterior side of the storm, on a rising barometer; as is frequently experienced in navigating between Europe and the northern portions of America. But the slower easterly rotation of the earth in higher latitudes, in a constantly reducing ratio as the gale advances, appears to afford a better explanation of this somewhat common inequality of force in the anterior and posterior sides of the storm.

† Recital 160, and others.

 Showing the Daily Progress of the Cuba Hurricane with the Direction of Wind at the hour of 6 P.M. on the 5th 6th & 7th days of October respectively 1844

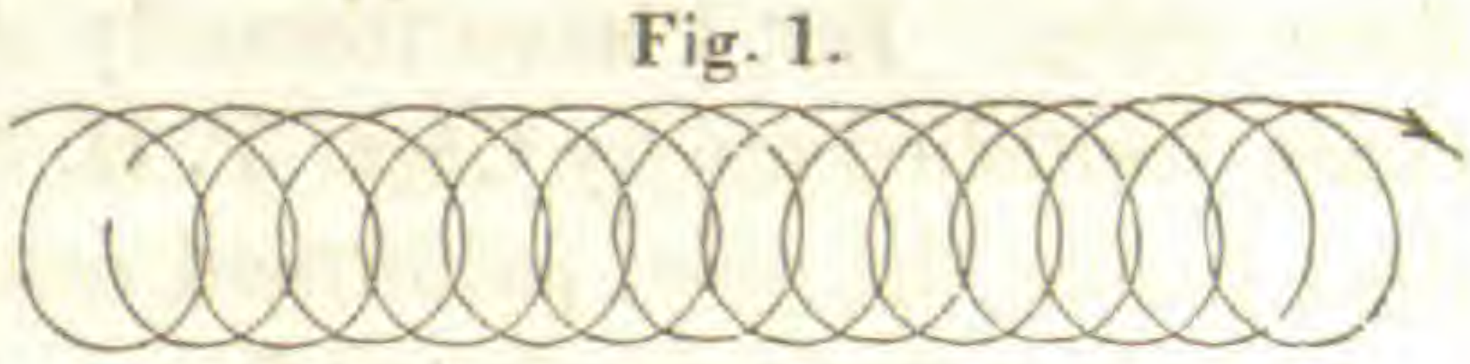
The numbers show the places or vessels named in the recitals.

Engd. by J.M. Atwood N.Y.

Oscillations of the Axis of Rotation.—We may infer that the centrifugal force, within the body of the revolving storm, will seldom be equally balanced on all sides, by the exterior pressure which is indicated by the barometer, and that the impulsion which results from the temporary predominance of pressure on any side, will be propagated around the axis, causing the latter to move in a series of spiral revolutions, or curvilinear deviations, during its progression. This revolving oscillation may often be observed, even where there is no progression of the whirling body; as in the case of a vortex in water discharging into an orifice or through a funnel. This oscillation of local pressure and the eccentrical revolution of the axis, may go far, among other causes, in explaining the *flaws*, *puffs*, *gusts*, and *squalls*, as they are loosely and sometimes interchangeably called, which are so very common in violent storms; and, in the larger movements, may account for some of the irregular changes previously noticed.

Phenomena of Axial Oscillation.—The specific course of the actual center of gyration, under the oscillations referred to, must differ greatly in storms which have different rates of progression. It has been shown by Mr. Piddington and Mr. Thom that the progression of some storms of the Asiatic seas and Indian ocean, during some portions of their advance, has been as slow as *three miles and even two and a half miles per hour*. This remarkably slow progress, in connexion with the axial oscillation, must produce unusual conditions in places near the center of the storm, and may serve to account, in part at least, for the most extraordinary series of opposite and successive shifts, veerings, and calms, recorded by Mr. Lloyd as having occurred at Port Louis, Mauritius, in March, 1836, in a slow moving hurricane which lasted three days.* In this storm, the line pursued by the axis of gyration might have been somewhat like that seen in the following figure.

Fig. 1.



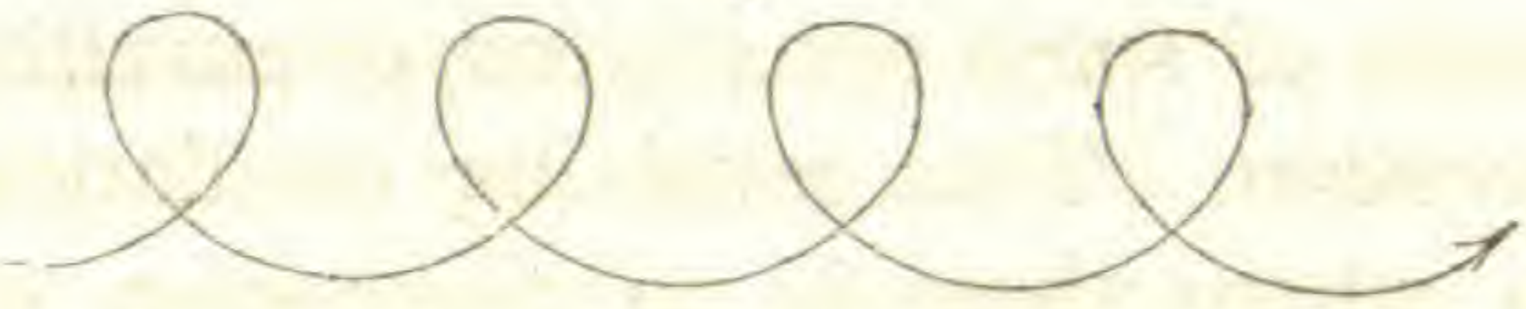
In this case, if we suppose the circuit of the axial oscillation to have been equal to the diameter of the lull, inclusive of the interior edge of the gale, this course of its axial point would produce, on or near its center path, a series of oscillating changes not unlike those observed by

* London Nautical Magazine, June, 1837.

Mr. Lloyd. It is proper to add, also, that Port Louis is situated near an abrupt ridge of mountains which might have greatly disturbed the regular course of the wind at that place.

With a higher rate of progression the center of gyration might move on a line or course more like the following:

Fig. 2.



But with a very rapid progression in the body of the storm, like the case before us, the revolving center or point of gyration might describe a line more nearly like one of the two following figures.

Fig. 3.

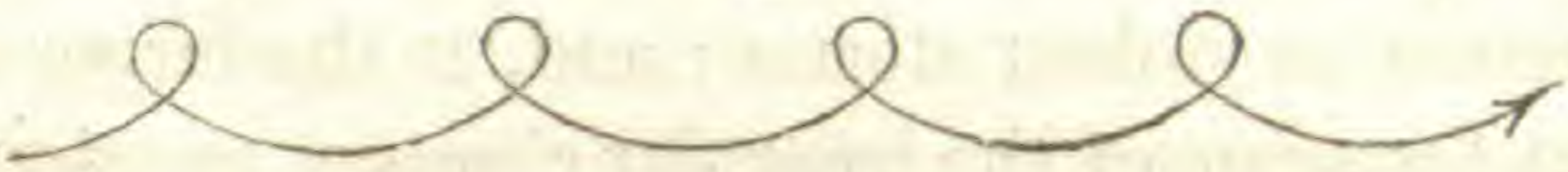
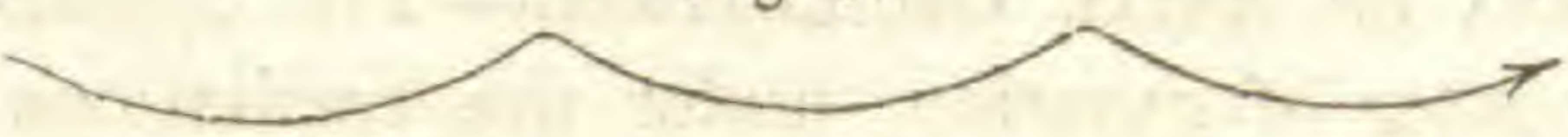


Fig. 4.



Such oscillations of the axis of a storm, however, cannot easily be detected, for want of sufficient and exact observations in the axis path, in those regions where the winds have free action. They may be best noticed in a storm of slow progress, like that of Mauritius, above mentioned, but may also be often evinced in other observations. In the case before us, we find cause to infer that some deviations existed in the axial course, without being able to determine these with precision.

Circuit Sailing in Storms.—In the rapid progression of the Cuba hurricane, no great portion of a circuit of revolution would be described by any vessel, in sailing before the wind. Nor is the ordinary progress of the Atlantic gales sufficiently slow to induce often such a result, under the courses ordinarily steered in these gales. But I have formerly shown a case on the American coast, furnished me by Capt. T. H. Sumner, where a ship, in scudding before the gale, performed nearly half the circuit of the horizon, before the gale abated.*

In the slow progression found in storms of the eastern seas, as already noticed, not only a complete circuit of revolution, but more

* Ship *Cabot*. See Journal of Franklin Institute, June, 1839, vol. xxiii, p. 370; with a diagram.

than one circuit might sometimes be made in a gale by the same vessel, in sailing around the axis of the storm; thus adding another practical demonstration of its revolving character. One such case of complete circuit sailing I have referred to, in 1836.* Mr. THOM, in his account of the Rodriguez storm of April, 1843, has shown that the *Robin Gray* run once and a half times around the axis of the storm, from left to right, ↻, (this being in the *southern* hemisphere,) till, being thrown on her beam ends, she was prevented from continuing her circuits. In the same storm the *Argo* made part of her second circuit, scudding round in the gale in the same direction. In like manner the *Margaret* made a circuit and a quarter around the axis, chiefly in the heart of the gale. Several vessels, after once falling out of this hurricane, pursued their course, again overtook it and plunged into the heart of the storm, where they suffered most serious disasters.† It appears probable, and indeed certain, that nearly all of the great loss and damage sustained in this hurricane might well have been avoided, by a knowledge of the laws of rotation and progression in these storms.

But the most striking case of circular sailing in a storm is that of the *Charles Heddle* in a hurricane near Mauritius, in February, 1845, which has been furnished me by Mr. PIDDINGTON. This was a clipper built vessel, once a slaver, and was bound from Mauritius to Muscat. It appears from the log, that in her course, round and round in the gale, the wind veered five complete revolutions in one hundred and seventeen hours, with an average run of eleven and seven-tenth knots per hour, the whole distance thus sailed being thirteen hundred and seventy-three miles; while the progression of the hurricane, at this period, *was less than four miles an hour*. The average distance from the gale's axis is estimated at about forty-five miles. During this time, the vessel made good a course S. W. $\frac{3}{4}$ W., three hundred and fifty-four miles, only; nearly on the usual course pursued by the hurricanes, near Mauritius.‡

* Lond. Nautical Magazine, April, 1836, p. 205. This Journal, vol xxxi, p. 122.

† Nature and Course of Storms in the Indian Ocean; with Diagrams. Lond. 1845.

‡ These highly interesting cases of circuit sailing in storms give proofs of their revolving character not unlike those which are afforded of the earth's rotundity in voyages of circumnavigation: and, like the latter, may be received by some who perhaps may not be able to appreciate the evidence, equally conclusive, from other sources.

These are results obtained by Mr. PIDDINGTON, who has already published his Twelfth Memoir, and who informs me that he is preparing another on this hurricane of the *Charles Heddle.* In his Eleventh Memoir, he has given an account of two storms, which were nearly contiguous, but on opposite sides of the equator, and revolving in counter directions, ↻ ↺, each according to the law of rotation and progression of its own polar hemisphere.*

VERTICAL HEIGHT OF THE STORM WIND.—What is the general height or thickness of the storm, and by what means can this be approximately determined? These questions and their solution are doubtless of some importance in their bearing on meteorological theories, and seem to deserve our attention.

In nearly all great storms which are accompanied with rain, there appear two distinct classes of clouds, one of which, comprising the storm-scuds in the active portion of the gale, has already been noticed. Above this, is an extended stratum of stratus cloud, which is found moving with the general or local current of the lower atmosphere which overlies the storm. It covers not only the area of rain but often extends greatly beyond this limit, over a part of the dry portion of the storm, partly in a broken or detached state. This stratus cloud is often concealed from view by the nimbus and scud clouds, in the rainy portion of the

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* Prof. DOVE, in his paper on barometric minima, alledged that storms in general are whirlwinds,—that the turning or rotation of storms in the southern hemisphere is in the opposite direction to those in the northern; and he adduced certain European storms as turning from S. W. to W. and N. W., and says that most of the hurricanes compared by him, in the southern hemisphere, are in the opposite direction, that is S. W., S. E.; but probably different in different longitudes, (Pogg. Ann. 1828, pp. 597, 598.)—Both these directions, however, are seen to be contrary to the true rotative direction in the storms thus refered to; and I am at a loss to know if he did not then consider the opposite veering of the winds, on opposite sides of the barometric minima, to be evidence of two opposite and distinct rotations.

The opposite rotation and polar progression in the storms of the two opposite hemispheres, had early appeared to me as a probable if not necessary result, and was soon confirmed by the evidence of numerous facts, of an isolated but uniformly consistent character. This point was summarily alluded to in this Journal for October, 1833, vol. xxv, pages 121 and 128. In the last named instance, the complete inversion of the storm-winds, as exhibited on the center-path of the storms in southern Australia, was referred to as conclusive evidence.

Col. REID, in his work, published in 1838, has given the results of his inquiries on the rotation and progression of the hurricanes of the South Indian ocean, which afford ample proofs of the opposite polar relations in the storms of the two hemispheres.

storm, but, by careful observations, may be sufficiently noticed to determine the general uniformity of its specific course, and, approximately, its general elevation.

The more usual course of this extended cloud stratum, in the United States, is from some point in the horizon between S. S. W. and W. S. W. Its course and velocity do not appear influenced, in any perceptible degree, by the activity or direction of the storm-wind which prevails beneath it. On the posterior or dry side of the gale, it often disappears, before the arrival of the newly condensed cumuli and cumulo-stratus which not unfrequently float in the colder winds, on this side of the gale.

It appears, therefore, that the proper storm-wind revolves entirely below the great stratus cloud which covers so large a portion of the storm; and we may infer, also, that the production of the accompanying rain and the depressing effect of the storm's rotation on the barometer, are chiefly confined within the same vertical limit. In regard to rain, this result is in accordance with observations on the quantity which falls at different elevations above the earth's surface; and in the case of the barometer, a like accordance is shown in the diminished range of the mercury in storms which is found in ascending from the ocean level.

The general height of the great stratus cloud which covers a storm, in those parts of the United States which are near the Atlantic, cannot differ greatly from one mile; and perhaps is oftener below than above this elevation. This estimate, which is founded on much observation and comparison, appears to comprise, at the least, the limit or thickness of the proper storm-wind, which constitutes the revolving gale.*

It is not supposed, however, that this disk-like stratum of revolving wind is of equal height or thickness throughout its extent,

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* See this Journal, vol. xxxi, p. 127—128. If a disk be cut from the thin paper of Chart IV, of a size which will represent one thousand miles in diameter, it will be found to have a thickness which represents more than a vertical mile, by the scale of the chart. A disk of the same size, but on a scale representing a storm of but 400 miles diameter, if cut from the paper of this Journal, will also represent more than a mile of vertical thickness, in the storm. These and other analogous considerations, deserve the attention of those who may think that winds are mainly induced and supported by movements or influences of a vertical character or tendency. It might be useful for those holding such views, to attempt to draw out the supposed paths of vertical induction and geographical progression in the winds, on an accurate and uniform linear and vertical scale, for the purpose of attaining a more precise standard for estimating the supposed vertical action or influence.

nor that it always reaches near to the main canopy of stratus cloud. It is probably higher in the more central portions of the gale than near its borders, in the low latitudes than in the higher; and may thin out entirely at the extremes, except in those directions where it coincides with an ordinary current. Moreover, in large portions of its area there may be, and often is, more than one storm-wind overlying another and severally pertaining to contiguous storms. In the present case, we see from the observations of Prof. Snell and Mr. Herrick, at Amherst, Mass. and at Hamden, Me., (115 and 135 *b*) that the true storm-wind, at those places, was super-imposed on another wind; and various facts and observations may be adduced to show that brisk winds, of great horizontal extent, are often limited, vertically, to a very thin sheet or stratum.

Local Tornado in the Cuba Hurricane.—The accounts from Matanzas mention a destructive phenomenon of this kind as having taken place at Yabu, (in the central part of Cuba, lat. 22°, lon. 29° 34′, on the right of the axis line,) during the hurricane. It is described as "a tremendous water spout which passed through the place, doing much damage," and confined to a narrow path. "The effects were the same as if a violent river had run through the town, leaving a kind of channel." This case has since been mentioned, erroneously, as having occurred in Mexico.

The appearance of violent tornado-vortices within the body of a great storm is not new nor very unfrequent. A remarkably destructive case occurred at Charleston, S. C., on the 10th of Sept., 1811, during a great storm which visited our coast. It caused the loss of a great amount of property and about twenty lives. Its track was about one hundred yards wide; and it followed the course of the local storm-wind, from southeast to northwest, transversely to the progression of the great storm. Two very violent tornadoes appeared in New Jersey, in a general storm, on the 19th of June, 1835, moving in different but nearly parallel paths, at an interval of several hours. These pursued the course of the higher general current which then overlaid the great storm.* Several other tornadoes, together with numerous gusts

* One of these was the New Brunswick tornado, described in this Journal, vol. xli, pp. 69—79. See also foot note, vol. xliii, p. 276.

and severe thunder squalls appeared on the same day, in different places, within the compass of the same general storm. Another tornado occurred on the 13th of August, 1840, at Woodbridge, near New Haven, Ct., during a general storm, following the local direction of the storm-wind, from S. S. E. to N. N. W.; transversely to the course pursued by the larger storm.

These with other cases which might be adduced, may serve to show that the small tornadoes which sometimes occur in great storms have no essential or inherent connexion with the vortex of the larger storm, even in those cases in which the courses of progression may chance to coincide.*

We have further to notice the barometrical phenomena of the two Cuba storms, their geographical relations to contiguous winds and currents of the lower atmosphere, and some of the practical bearings of the subject upon the interests of commerce and navigation.

Art. XVI.—*On Zoophytes*, No. II; by James D. Dana†.

8. The word zoophyte has been translated *an animal that grows like a plant*, and in this sense it is well applied to the several species so designated. It is a curious question, how animals can have the mode of growth of vegetation, and yet be wholly removed from the vegetable kingdom; how some species may form mossy tufts, others lichen-like fronds, others resemble shrubs and trees, and yet possess not a single one of the essential characteristics of vegetable life: how, too, these animals form structures of *coral*, a material harder than marble and like it in composition, and thus cover the ocean's bed with shrubbery and flowers of living stone. There seems to be much mystery in the subject; but the greatest wonder will be found to consist in its simplicity. It is in fact so extremely simple, that the mind in ignorant surprise overleaps the true explanations to be found close at hand,

* In like manner, common thunder storms are often known to appear in or above the local portions of a great storm. An examination of this class of storms will show that the narrow tornadoes and thunder storms often extend to a greater height than the great gales or hurricanes.

† The abstract of the Exploring Expedition Report on Zoophytes commenced in the last number, is here continued, with such modifications or additions from other sources, as would adapt the subject to the pages of this Journal.

and goes on wondering at complexities of its own creation. Life we cannot understand; but the facts which living beings present to the eye may be read with as much clearness in the animalcule, as in the animal of higher intelligence; and even more distinctly in the former, as its organization is less complex. We shall find as we proceed that the formation of coral is no more surprising than that of the oyster shell or the bone of the quadruped, as the power of secretion belongs to the most stupid lump of vitality, and is the lowest of all the attributes of living beings. We shall learn too that the mode of growth which leads to the spreading tree as its result, is a consequence of simplicity, and far less wonderful, if a comparison can be made, than the process which models the diviner form of man, though the zoophyte is usually deemed the greater mystery. Corals and coral zoophytes may become a very common-place subject to some minds, when brought out of the realms of mermaids "deep in the wave;" yet we venture to believe that the world as created by its Author needs no finishing touch from the hand of man to render it worthy of our admiration and profound study.

General Characteristics of Zoophytes.

9. Zoophyte is a general term used in the same manner as *plant* in the vegetable kingdom. There are species, as we have stated, which are single animals, and others like the Madrepore tree that are compound; some form coral, and others, not. The several individual animals in either case are called *polyps*.

A mouth, and a tubular cavity below possessing powers of digestion and assimilation, are all the essential constituents of a polyp. They thereby eat, digest, and grow; and reproduction follows as a result of the animal structure. They are usually attached at base, and at the opposite extremity have a circle of arms (tentacles) around the mouth. Thus equipped, they fulfill their destiny, without any of the senses, without a distinct nervous system, with no provision of glands, no heart or system of circulation, and no distinction of sex. Such is the polyp in its simplest form. Fixed in its site upon some rock or sea-weed, it remains with open mouth and extended arms, waiting for such chance bits as may come in its way.

10. In more precise language, it may be described as *an animal of the class Radiata, having an inarticulate fleshy body near-*

ly cylindrical; a circular or elliptical summit called the disc, bordered by one or more series of tentacles, and an opening or mouth at the centre of the disk: internally, *a visceral cavity which is closed below; no distinct vascular system; an imperfect nervous system or none; no senses but that of touch; no distinction of sex.* The mouth is a simple opening through the fleshy disc, without organs of manducation, and it is the only exit from the visceral or internal cavity. The body, and in most instances, the tentacles also, are expanded by means of water received from without, mostly through the mouth, and which is ejected on contraction. Instead of having gills,* the whole surface of the animal, inside and out, takes part in the function of aëration, through the air of the exterior and interior waters.

The polyp in its simplest form (see figures 2 and 3, page 197) is essentially then merely a fleshy bag, or tube of flesh, closed at one end; and within the walls of this tube nearly all the processes of life are carried on. There is no division of labor—no separate organs for different functions, as in the higher animals; nutrition, aëration, and reproduction, belong equally, as far as can be discerned, to all parts of the simple structure. With animals of this kind it would seem to be of little importance which side of the bag was innermost; and it is a fact with the Hydras that they may be turned inside out, and still eat, digest, and perform all the functions of life as before.

11. Only the lower grade of polyps have the extreme simplicity above described. As a *first* step in advancement, the upper part of the visceral cavity becomes partially separated from that below and serves as a stomach. The *second* step is more important; it consists in a localization of the function of reproduction, in addition to the farther perfection of the stomach. The stomach, a simple tube, occupies the centre of the visceral cavity, being attached to the disc immediately below the mouth. The space in the visceral cavity outside of the stomach and below it, is divided into vertical compartments by a radiate series of fleshy lamellæ or plates, part of which bear seminal cords on the margin, and part, clusters of ova.

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* Organs somewhat resembling gills are found in the family Zoanthidæ; but none have been detected in other polyps.

These higher polyps, though similar in many respects, are thus distinct from others in having a set of organs growing from the walls of the visceral cavity devoted to the function of germination instead of this function residing in the walls themselves; and they illustrate the first step in the system of localization,—the distributing of different processes in the animal economy to distinct organs—by which the higher animals differ from the lower. The ova in the one case grow outward from the sides of the polyp, escaping laterally by simple pullulation: in the other, they form at the margin of the ovarian lamellæ, *within* the visceral cavity, and escape by passing up through the stomach and mouth.

12. It is perceived that the mysterious polyp is a very simple kind of organism, and we thus far detect no evidence of a vegetable nature. We observe that while the plant extends its roots and absorbs nutriment from the soil or atmosphere, the polyp obtains its nutrition, like other animals, from food in a stomach; in the process of digestion, assimilation, defecation, as well as the action of the circulating fluid on air, they are *in toto*, animal.

13. Yet we are struck with the points of external resemblance—the flower-shaped disk—the circle of tentacles corresponding to the petals of the flower—and the series of germinal lamellæ or dissepiments in the higher grades, situated within, like the stamens, and pistils or carpels of the flower.

This resemblance is rendered more striking by the mode of *budding*, on which the compound structure of zoophytes depends, as it is singularly like the production of buds in a plant. As seen externally, the bud in many instances appears first as a slight swelling on the side of a polyp: it enlarges, and after a while a new polyp gradually grows out, with tentacles and visceral cavity complete: it usually remains thus united to the parent for life, though sometimes becoming detached and swimming off free. Comparing it with the growing plant-bud, we find no essential difference in the process, though in one case the result is an animal, and in the other a flower or branch of leaves. The new polyp at first communicates internally with the parent by its visceral cavity as well as the tissues of its sides, and often this intimate connection continues after becoming adult.

This process, as is obvious, may go on without limit; the parent may give out other buds, and all may add to the number by continued budding: and why then should not the polyp form a tree, at least as well as the budding plant? This is in fact the true explanation of the formation of a zoophyte. An accumulation of polyps goes on by this succession of developments, and the same forms result as in vegetation—the tree, the shrub, the lichen, cactus column, or sphere. The laws governing this process will be considered on a future page. We repeat here a former remark that this budding may and does take place independently of coral secretions, as the secretion of coral is not an essential character of polyps, though belonging to many of them.

14. The compound zoophyte is hence a result of the budding process. The young polyp, after a short life of freedom, (a few days or less,) finds a place of attachment and then begins to bud, and by this means of multiplication, the stem rises, and branches are formed. The zoophyte is therefore a cluster of polyps, having generally an intimate connection with one another. The animals have each a stomach, with tentacles and a mouth for conveying food to it: but there is a free intercommunication of the fluids through the uniting tissues, by side pores or lacunes, and in some cases, even by the visceral cavities. It is precisely like a thousand digestive sacs and mouths contributing to the nutriment of a single layer of animal tissue.

15. A still more singular mode of reproduction, often the subject of remark, presents another striking analogy between the plant and the zoophyte:—the process of reproduction from *artificial sections.* It is well known that we may as easily raise a polyp from cuttings as a tree. Trembley and Baker* long since proved fully the title of the Hydra to the name it bears; for the knife was unsparingly used, and only resulted in multiplying Hydras. They were cut into halves, and soon each was a perfect Hydra. One was divided into three parts, and in three or four days in summer, the tail had produced a head, the head a tail, and the middle part a head at one end and a tail at the other; and even before completion, they sometimes began to give out buds. From forty parts as many Hydras resulted. The body slit

* Abraham Trembley, on Freshwater Polyps, (Memoires pour servir à l'histoire d'un genre de Polypes d'eau douce,) 1 vol. 4to., *Leyden*, 1744; and Phil. Trans., vol. viii, of the Abridgment, 1742.—Henry Baker, A Natural History of the Polype, 8vo. *London*, 1743.

open reunited, even if previously laid out flat, like a membrane, and new tentacles in a short time replaced those that were cut off. Two polyps may be made to change heads, for one may be grafted on the body of another. Every portion of the animal excepting perhaps the tentacles, which failed in the hands of Trembley and Baker, is thus capable of forming a perfect Hydra. "What is still more extraordinary, polyps produced in this manner grow much larger and are far more prolific in the way of their natural increase, than those that were never cut. It is very common when a polyp is divided transversely, to see a young one push out from one or other of the parts, and sometimes from both of them, in a very few hours after the operation has been performed; and particularly from the tail part, two or three are frequently protruded in different places and at different times, long before that part acquires a new head, and consequently while it can take in no fresh nourishment to supply them with; and yet the young ones proceeding from it, under these disadvantages, thrive as fast, and seem as vigorous as those produced by perfect and uncut polyps."*

16. Another fact equally strange is presented by these animals. Sir John Graham Dalyell, whose investigations in this depart-

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* Baker, pp. 92, 93.—We cite the following closing remark on this subject from the highly classical work of G. Johnston, M. D., on British Zoophytes, (History of British Zoophytes, Edinburgh, 1838; p. 107.)

" When such things were first announced—when to a little worm the attributes of angelic beings were assigned,† it is not wonderful that the vulgar disbelieved, albeit credulity may be their besetting sin, when even naturalists, familiar with all the miracles of the insect world, were amazed and wist not what to do. 'Il faut,' exclaimed Reaumur, 'il faut porter la foi humaine plus loin qu'il n'est permis à des hommes éclairés, pour le croire sur le premier témoignage de celui qui le raconte, et assure l'avoir vu. Peut-on se résoudre à croire qu'il y ait dans la nature des animaux qu'on multiplie en les hachant, pour ainsi dire, par morceaux?'‡ But this illustrious naturalist was himself the first to promulgate, and experimentally to verify, the discoveries of Abraham Trembley, which have been fully confirmed by many subsequent inquirers, and are now made so familiar to us by their admission into elementary works and treatises on natural theology, that we read of them with little surprise and without incredulousness."

† Vital in every part, not as frail man
In entrails, heart or head, liver or veins,
Cannot but by annihilating die;
Nor in their liquid texture mortal wound
Receive, no more than can the fluid air,
All heart they live, all head, all eye, all ear,
——————and, as they please,
They limb themselves, and color, shape or size
Assume, as likes them best."—Milton.

‡ Hist. des Insectes, vi, Pref. 49.

ment of science are among the most remarkable that have been made, has observed that a species of Actinia on the coast of Scotland, instead of waiting to be cut up into bits in order to raise a progeny, actually separates fragments for the purpose from its base, by the ordinary process of growth. "Small irregular fragments of no determinate shape detaching themselves from the base, gradually become perfect Actiniæ; in the course of a year, seventy were thus detached from its basal margin, which consequently became ragged and disfigured. The external organs were gradually developed, and in three weeks the young Actiniæ were perfected from the rudest and most misshapen fragments."* We are at once reminded of the bulbs that grow from certain plants, and drop off to sprout up, bud and flower. Instead of proving the vegetable character of the polyp, these facts only establish the identity of certain laws of life in both kingdoms.

17. Reproduction in polyps, we thus perceive, takes place both by means of ova and buds; that is, these animals are both *oviparous* and *gemmiparous.*

I. *Ova.* The ova either (1) form in the sides of the animal, and grow from the outer surface;—or (2) they form from internal lamellæ, and escape through the mouth.—In some instances, as distinguished by M. van Beneden, (3) an ovum appearing at first to be single, undergoes a subdivision in its yolk, and becomes a number of distict ovules, each producing separate young. The ova in (1), are sometimes spoken of as *bulbs.*

The ova sometimes produce the young before they leave the polyp, and the animals are then in fact *viviparous.* But as the external waters have free admission to the interior, this may be considered but an accident in the oviparous mode.

II. *Buds.* Buds (1) develop young which are *persistent*, that is, remain attached to the parent:—in other cases (2) they develop young which separate when mature, or are *caducous:* sometimes (3) the buds proceed at intervals from an elongating shoot called a *stolon:* again, (4) they sometimes separate as *bulbs* before the young are developed: again, (5) these separating bulbs, before development, may contain ova.† This last process is analogous

* Cited from a recent letter to the writer.

† This last fact was first distinguished by M. van Beneden.—See his elaborate memoirs on the Tubularidæ in the Transactions of the Royal Society of Brussels; also, Ann. Mag. Nat. Hist., xv, 346.

to the occurrence of eggs in the larves or imperfect young of insects.

Artificial sections may be considered another means of reproduction. The process however depends on the same cause as that of budding—the absence of a concentrating nervous system: it matters little whether the fragment remains as a part of the parent, or be detached from it.

18. The facts which have been presented, indicate a natural subdivision of Zoophytes into two groups or orders, as follows:

I. Hydroidea. Visceral cavity, a simple tube; reproductive functions residing in the general walls of the cavity; young or ova pullulating from the sides of the parent.

II. Actinoidea. Visceral cavity divided vertically by fleshy lamellæ; reproductive functions belonging to the margin of the fleshy lamellæ; young or ova set free in the visceral cavity, and escaping from it by passing up through the stomach, out of the mouth.

The Hydroidea are small species, sometimes forming corneous, but never calcareous coralla, and contributing nothing essentially to reefs. The name is derived from Hydra, one of the included genera. The order Actinoidea comprises all the ordinary reef-forming Zoophytes, together with the Actiniæ and allied species. The name is from Actinia, which comes from the Greek *ακτιν*, *a ray of the sun*, and alludes to the radiate flower-like summit.*

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* The characters given exclude the Bryozoa, a group embracing the Flustras and Cellepores. Their relations to zoophytes are briefly explained in the last volume of this Journal, page 287. They have an intestine, which curves back and terminates in an anus near the mouth, and in this and other respects differ from true zoophytes, as we have used this term.

Zoophytes pass into the class Acalephæ through the Actinecta on the part of the former, and the Porpitæ and the Velellæ on the part of the latter, which are all floating oceanic species, and have nearly similar tentacles about a central mouth. Passing beyond these species, the structure of the Acalephæ varies widely from the Actinoidea; the internal cavity, the germinal system, tentacles, and general habit, becoming very different. The Hydræ closely resemble the young of certain Acalephs, and have been lately classed with the Acalephæ, especially on account of the structure of their tentacles, which are furnished with minute dart-bearing or filiferous sacs. (See Dujardin, Ann. des Sci. Nat., iv., 1845, p. 258.)

The *Sponges* are also excluded; if animal, they have little in common with zoophytes excepting their plant-like forms and the most general properties of animal life, as no distinct animals allied in any way to polyps have ever been detected. Of recent authors, Grant, Audouin, Milne Edwards, Bowerbank, Dujardin, and Laurent, consider sponges as animal; while Link, Blumenbach, Owen, Hogg and G. Johnston, are inclined to place them in the vegetable kingdom.

Order Hydroidea.

The Hydroidea are minute polyps of extreme simplicity of structure and delicacy of form. Though sometimes single animals swimming at large or attaching themselves at will, like the Hy-

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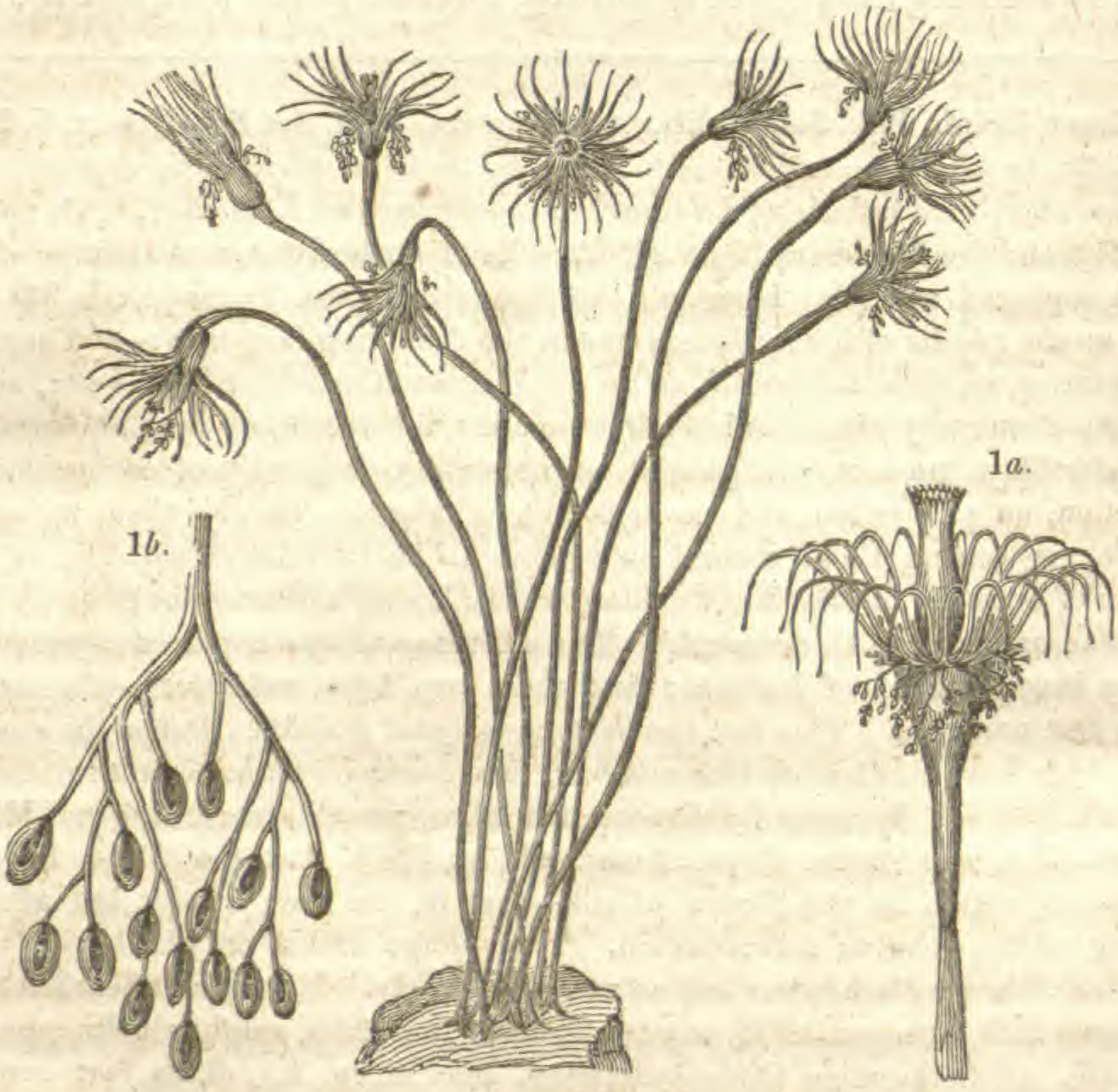
See Grant, Edinb. Phil. Jour., xiii, xiv; Dujardin, Ann. des Sci. Nat., x, 5, 2d series, 1838, in which he endeavors to show, by minute microscopic research, that they are compound infusoria; Laurent, on the Spongillæ, L'Institut, 1840, pp. 223, 231, 240, and the Microscop. Jour., i, 78, who describes the reproductive organs of the supposed animals; Hogg, on the Spongilla, Linn. Trans., xviii, 390, who sums up the results of his investigations in the following language :—"They have no tentacles, no cilia, no mouth, no œsophagus, no stomach or gastric sac, no gizzard, no alimentary canal, no intestine, no anus, no ovaria, no ova, no muscles or muscular fibres, no nerves or ganglia, no irritability or powers of contraction and dilatation, no palpitation, and no sensation whatever. Surely, then, we cannot any longer esteem these natural substances to be individual animals, or even groups of animals, in which not one organ, nor a single function or property peculiar to an animal, can be detected." The existence of ova is placed beyond doubt by the investigations of Laurent; and these ova have animalcule-like motions when first produced. This fact has been considered decisive; but as the spores of some Algæ have similar life-like motions, this evidence alone is not satisfactory. The analyses of Sponges by Croockewit have proved, according to Mülder, (Chem. Veg. and Anim. Phys., Amer. ed., p. 303,) that the fibres have the same composition as the *fibroïn* of silk—that is, the part of silk left after dissolving out the gelatine and albumen. The sponge differs only in having the fibroïn combined with sulphur, iodine and phosphorus. It consists of carbon 48·01, hydrogen 6·35, nitrogen 16·06, oxygen 26·40, iodine 1·05, sulphur 0·46, phosphorus 1·67. (Scheikundige Onderzoekingen, Deel ii, p. 1.) This fact certainly adds weight to the side of the animal nature of sponges.

Judging from all the recent investigations, it may be received as most probable, that *sponges are the result of animal growth;* that the minute component animals are more analogous to infusorial animalcules than polyps; that they receive nutriment by absorption at the surface without distinct stomach cavities opening outward through a mouth; and owing to this simplicity of structure, the individuality of the animalcules is nearly or quite lost in the general structure, just as the individuality of cellules in a simple growing animal is merged in the resulting organism; that they are therefore in effect simple individuals, though they may be viewed as analytically compound. A perfect analogy is afforded by vegetation: for while in most plants growth takes place through the formation of successive buds, (plant-individuals,) all at first as distinct nearly as the polyps of a zoophyte, in others, (like some Algæ,) there is a progressive elongation or *enlargement* of a growing stem or frond, without any appearance of constituent parts or buds in any period of the development; and reproduction proceeds from the surface of the general structure, as in sponges.

The limits of the two kingdoms of nature, the vegetable and the animal, are still in obscurity. It would seem as if the two lines diverged from the same low organisms; for besides the moving spores of Algæ, there are actual animalcules which are claimed by the Botanist, on the ground that they act on the atmosphere like plants, giving out oxygen instead of carbonic acid. The argument appears to be good, notwithstanding the living motions they present, and their complete redra, (figs. 2 and 3,) they usually form compound groups, hundreds and often thousands to a cluster. Some, as in the annexed figure* (fig. 1,) grow in crowded tufts or thread-like stems; ma-

Fig. 1.



semblance to other infusoria. The effect mentioned depends on the nature of the process of nutrition, which is of more importance than the motion of vibratile cilia. The principles of growth depend on vitality; but the animal functions consist more or less completely in the chemical processes of composition and decomposition constantly going on in the organism. Now, it appears to be a law which pervades all existences, organic and inorganic, that action must have its alternate season of rest; there is vibration in molecular forces,† as well as alternate action and rest in the operations of life. Consequently the successive changes attending nutrition and growth, going on in a monad, may give alternate or seriate action to the cilia or other means of motion; and if sufficiently minute, and free to move, the organism will have progressive motion, whether plant or animal. No nervous system is necessary. In higher animals a nervous system is given to accumulate and concentrate power; in a higher plant, there is no nervous system, and little concentration, and the organism remains fixed without motion. Owing to the constitution of the plant, the action on air results in giving out oxygen, and it appropriates inorganic substances as nutriment: and for a like reason the animal gives out carbonic acid on respiration, and it subsists mostly on organic food.

* These figures are by J. P. Couthouy, and represent a species from Rio de Janeiro, which he designates *Tubularia ornata*. Fig. 1 shows the animal of natural size. These and the other illustrations, excepting figs. 2, 3 and 5, are copied from the Exploring Expedition Report on Zoophytes by the author.

† See Faraday's views on molecules, Phil. Mag., May, p. 345, 1846.

ny are much branched, and each branch is tipped with a star of tentacles, as in the following figures 4 and 5. In the coralla of

Fig. 2.

Fig. 3.

Hydra.

Fig. 4.

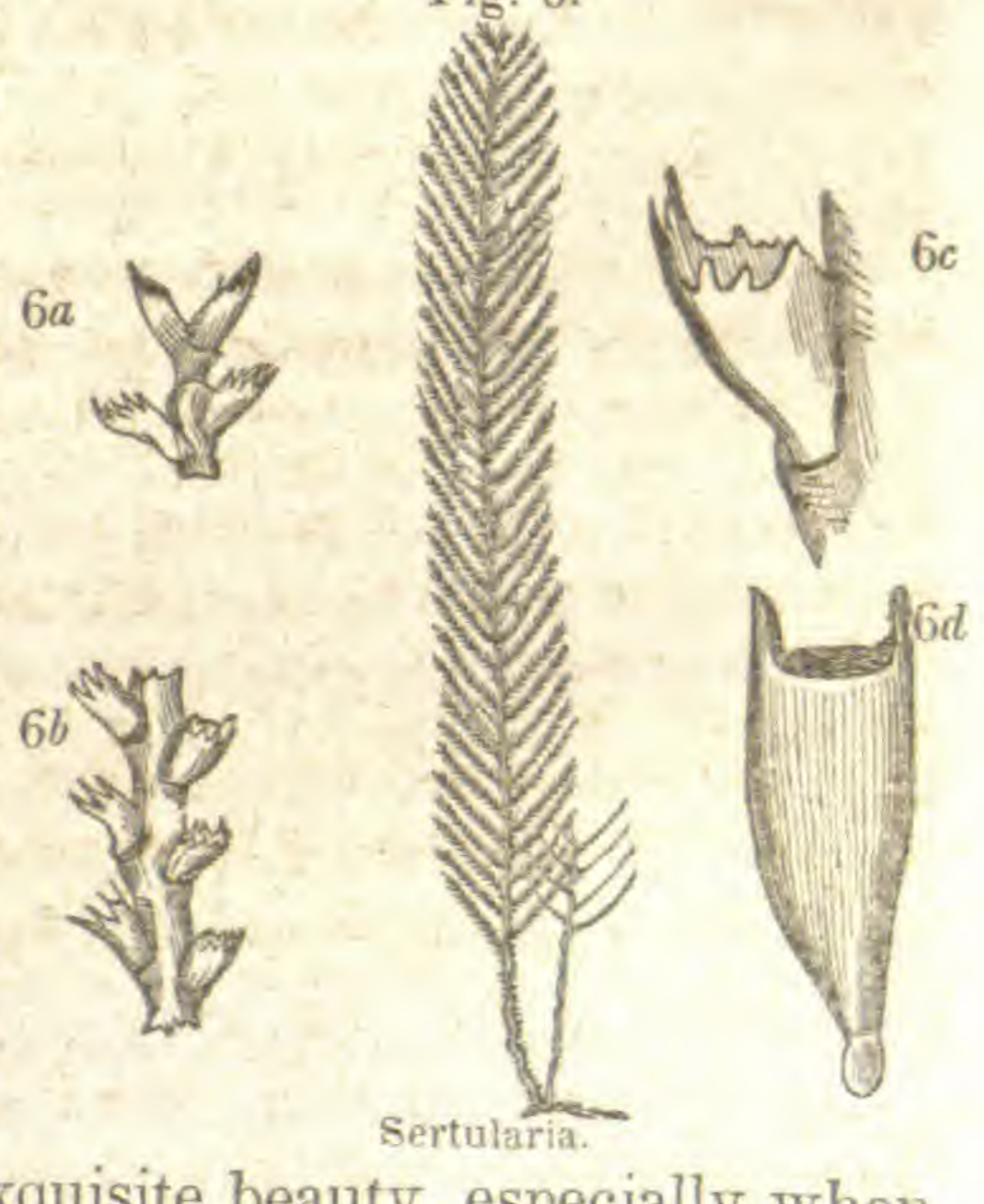
Fig. 5.

Campanularidæ.

a greater part of the species, minute calicles or little cups, but indistinctly visible to the naked eye, are arranged in one or more series along the branchlets, and the cluster is a neat imitation of the most delicate plumes (fig. 6) trailing vines or mossy tufts; and when alive, every calicle is the site of a polyp-flower. These zoophytes are occasionally but a few lines in height; yet others no less minute in their cells and polyps, attain a length of several feet.

20. The species are sometimes fleshy throughout, (figs. 2, 3,) forming no cells or corallum; though generally they have a delicate corneous or cartilaginous exterior; the minute cell or calicle is of the same nature, and is properly the exterior of that part of the animal which surrounds the stomach. The accompanying figure (6) represents one of the plumes,—a Sertularia,—with parts of a branch, (6*a*, 6*b*,) and a calicle (6*c*) enlarged. Under a microscope they are objects of exquisite beauty, especially when covered with the delicate polyp-flowers. On contraction, the arms

Fig. 6.



Sertularia.

of the little animal are here folded away (fig. 5.)* The stomach communicates with the tubular cavity below it, (figs. 4, 5,) and empties into this cavity the chyloid fluids after digestion. There is thus a community of visceral cavities often throughout a whole group, and the several polyps eat for the general good. The fluids (as the writer has observed, but which has been more fully ascertained by Lister and others) vibrate back and forth, or have a cyclosis movement like the circulation in a Chara, sometimes flowing quite into the stomach again; in connection with admitted water, they take the place of a proper circulating fluid.† There are floating particles as in the circulating fluid of other animals. Thus aëration and assimilation go on without any of the usual appurtenances of gills or glands.

The tentacles are commonly slender tubular,‡ and become expanded by injection with water. They usually aid in capturing animalcules, minute crustacea, or whatever prey comes within reach; and they apply themselves to the work with considerable dexterity, though less nimble than the more active Bryozoa. In some species they are short and sluggish, and can subserve only the purpose of aëration.

* There appears here to be a retreat into a cell; but in fact, it is only the head or upper part of the polyp, and not the polyp itself, which becomes concealed. The whole animal has a cartilaginous or corneous exterior, excepting the very summit and tentacles, and these consequently, on contracting, fall down into the extremity of the tube. This extremity is the part about the stomach, and the animal is usually larger here than below; when not larger, there is generally no retraction of the polyp's head.

† J. J. Lister, Philosophical Transactions, 1834, p. 369, with fine illustrations on plates 9 and 10.

We quote the following from his very interesting observations. The current "flowed in one channel, alternately backwards and forwards, through the main stem and lateral branches of a plume, and through the root, as far as the opacity admitted of its being traced; sometimes it was seen to continue into the cells. The stream was throughout in one direction at one time; it might be compared to the running of sand in an hour-glass, and was sometimes so rapid in mid-tide that the particles were hardly distinguishable; but it became much slower when near the change. Sometimes it returned almost without a pause; but at other times it was quiet for a while, or the particles took a confused whirling motion for a few seconds; the current afterwards appearing to set the stronger for the suspension." "Five ebbs and five flows occupied fifteen minutes and a half; the same average time being spent in the ebb as in the flow." Lister states that the vibrating motions of the internal axial fluids were first noticed by Cavolini in his *Memorie per servire alla Storia de' Polipi Marini*, published at Naples, in 1785.

‡ The Tubularidæ and Campanularidæ, are described by van Beneden as differing from the Sertularidæ and Hydræ in not having these organs properly tubular. The tentacles of the Hydræ instead of being naked are armed with minute filiferous capsules, which ally them to the Acalephs, (see note to p. 194.)

21. Reproduction takes place by all the different modes mentioned in § 17, excepting that from internal lamellæ, which characterises the Actinoidea.

Ova.—The ova grow from the sides either singly or in clusters; and the clusters are naked as in figure 1, 1*b*, or enclosed in membranous cases or vesicles. The figures 5, 6, 6*d*, 7, and 8,

Fig. 7. 7*a*

Plumularia.

Fig. 8.

Sertularia.

represent some of these ova-bearing vesicles. They gradually develop from the side of a branch, or at times from a creeping root-like shoot, which grows outward like the creeper of a plant, sending up its buds and flowers at intervals (fig. 8). They sometimes may be shown to be the production of particular polyps in a cluster, and in other cases individuality seems to be lost and they belong rather to the group as a whole. The ova are easily distinguished arranged along an axis, or on one side of the vesicle, and Lister has shown that they communicate through this main axis with the trunk of the zoophyte and the fluids vibrate into them. Dr. Charles Pickering, an associate in the Exploring Expedition, pointed out to me in 1838 the close analogy which subsists between the structure of a vesicle with its included ova, and a branchlet of the zoöphyte. This singular point has been thoroughly investigated by E. Forbes, Esq., and the fact of this arrangement fully ascertained.* The above figure (fig. 7) is a good example of the fact; it is by Dr. Pickering and was drawn from the specimen on which the observation was made. The vesicle to the right contains evidently in its structure all the elements of the central pinnate frond, and appears as if made by folding together the branchlets from either side of the midrib, these branchlets and traces of the calicles being distinct over the surface of the vesicle.

* Rep. Brit. Assoc. for 1844, p. 94.

On coming to maturity the ova develop their young, either at the time of leaving the vesicle or soon after, and the vesicle becoming vacated, drops off. The young soon plant themselves upon some support and bud and branch, and soon become a grove of corallines. According to van Beneden the Campanularidæ when first developed are like minute Medusæ in shape, and have eight eyes, which are lost as the animal attaches itself.* Sir J. G. Dalyell, who had previously observed their forms, states that the young, after the tentacles are formed, enjoys the faculty of progression by means of the inverted tentacula, as on so many feet, apparently to select a site; when again resuming the natural direction with the extremities upward, the lower surface fixes itself below and roots there forever.†

22. *Buds.*—Buds in the Hydras fall off after coming to maturity; but occasionally they give out successive shoots till small compound groups are formed, though ultimately becoming each an independent animal. In the Sertulariæ and most other species, the buds are persistent. In some instances, before the zoophyte has reached its limits in size, the number of polyps constituting it becomes immensely large. In a single specimen of Plumularia (P. angulosa), collected by the writer in the East Indies, there are about twelve thousand polyps to each plumose branch; and, as the whole zoophyte, three feet long, bears these plumes, on an average, every half inch, on opposite sides, the whole number of polyps is not short of eight millions; all the offspring of a single germ, and produced by successive buddings. In the development of the bud, there is at first a protuberance in which the chyloid fluids gain access, and either move by vibration or have a kind of circulation up along the sides and down the axis; after a while the calicle forms, the polyp extends its arms and begins its contributions to the body-coralline. The annexed figures represent different results of the process. In figure 9 the cells are in a

Fig. 9.

Fig. 10.

Fig. 11.

* Mémoires sur les Campanularies, &c. Brussels, 1844.

† Rep. Brit. Assoc. for 1834, p. 600.

single series, each polyp budding out one, which becomes the summit one, this another and so on. In figure 10 there are two series; the axis lengthens between the two terminal and then buds again other two at the extremity, and so the branch lengthens. In figure 11 there is a series of clusters, the budding process being in part intermittent.

In some Tubularidæ, certain caducous gemmules change into delicate flat memberless animals resembling a Planaria, and which consequently were called *planules* by Sir J. G. Dalyell.* These, according to Van Beneden, are the developments of the buds alluded to on a preceding page, (§ 17,) which contain ova.

23. Connected with the process of growth and reproduction, there is a corresponding process of dying often going on in the older parts of a zoophyte: the polyps disappear, and the lower branches often drop off, leaving the trunk in this part bare. These zoophytes are thus dying and budding in different parts at the same time. In the large species, the main stem or midrib of the zoophyte becomes lifeless, or a mere support for the numerous lateral plumes or branchlets.

24. Besides this mode of limiting the existence of these polyps, some Hydroidea are said to be absorbed in their cells, and after a while to reappear again; and this has been observed to take place at nearly regular intervals. All the polyp cells of a living group have been found, after a certain period, empty, or with only the remains of the wasted polyps, the fluid of the trunk showing the only evidence of vitality by its continued vibration. And in the course of a few days other polyps have appeared in the vacated cells, with the same perfection of form and the same activity and life as their predecessors. The polyp heads, as Sir J. G. Dalyell states respecting a Tubularia, sometimes seem to drop off like a deciduous flower, and again, after ten days or more, are reproduced. Harvey observes, that after he had kept his specimens two days, they began to look unhealthy; and on the third "the heads were all thrown off, and lay on the bottom of the vessel." After another three days, changing the water in the mean time, the polyps were entirely renewed, with no essential difference, except absence of color. The cold of winter is said sometimes to strip a corallum of its polyp-flowers, which remains thus apparently dead till

* Rep. Brit. Assoc. for 1834, p. 602.

spring, when it is warmed anew to life, and the flowers once more appear.*

25. In conclusion, the Hydroidea are animals with no *external* organs but tentacles and a mouth, and no *internal*, but a simple stomach cavity and its prolongation below in the form of a tube or tubular axis. *Without any special glandular system, and with but a single opening to the alimentary cavity*,—the food is digested by the gastric fluid of the stomach, and the refuse matter ejected by the mouth. *Without a special absorbent or a circulating system or branchiæ*,—the digested material of the stomach passes downward into the tubular axis, where it has a vibratory or cyclosis movement; and here it is farther elaborated by the action of air from the admitted water, and becomes absorbed and assimilated by the surface of the cavity, or of the tubular organs, cavities, or pores, connected with it—these chyloid fluids acting in place of a proper circulating fluid; aëration of the same also takes place through the tentacles and the exterior surface of the animal, which receive air from the waters about them. *Without ovarian glands*, almost any part of the polyp possesses the reproductive function, excepting the tentacles; and buds or ovules are formed, and pass out directly from the sides of the animal. *Without a distinct nervous system*, in addition to the above negative characters, every part seems equally a centre of organic forces (unless we except the tentacles), and consequently sections made almost indefinitely, still live and complete the entire polyp again.

ART. XVII.—*Law of Electro-Magnetic Induction;* by CHAS. G. PAGE, M. D., Prof. Chem. and Pharm., Columbian College, Washington, D. C.

As the first fruits of the *Axial Galvanometer*, (see this Jour., i, ii Ser., 242,) I have to communicate the establishment of a definite law of inductive action of currents upon soft iron, and a direct practical corroboration of the law of Ampère as to the modifying influence of distance upon induction.

First: *As regards the inductive action with reference to surface and mass.*—Although the weight of authority upon this point, has regarded the action of helices, spirals, or *concentrated*

* J. G. Dalyell, Edinb. New Phil. Journ., xvii, 411; Harvey, Proceed. Zool. Soc. No. 41, p. 55; Lister, Phil. Trans. 1834, 374, 376.

action upon soft iron, as proportional to the surface independent of the mass, I had long since suspected the fallacy of the position; and this mainly from the fact, that when the magnetism of soft iron was made to react upon the helix in the development of secondary currents, the intensity of such currents always appeared to be augmented in proportion to the increase of the mass of soft iron—*that is, with the same helix.* For instance, a tube of soft iron gave much less reaction, as judged of from the spark and shock, than when a solid bar of the same diameter and length was used; and from the well known law of action and reaction, nothing else could have been *inferred* than that the *development of magnetism was in proportion to the mass and not to the surface.* The *axial galvanometer* clearly establishes this point. The apparatus used in the experiments consisted of a small Grove's battery, of six pairs—three helices, formed each of the same length of wire, but each having central openings or *bores* of different diameter—several bars and tubes of soft iron,—and a delicate spring balance. The bore of helix No. 1 was $\frac{10}{20}$ inch diameter; helix No. 2, $\frac{11}{20}$, and helix No. 3, $\frac{12}{20}$. Soft-iron bar No. 1 was four inches longer than the helices, and $\frac{9}{20}$ inch diameter, and when suspended within the helix No. 1, was distant from it $\frac{1}{20}$ inch; having therefore freedom of motion within the helix. It is not important in these experiments, that the axis of the bar should exactly coincide with the axis of the helix; for the sum of all the actions is the same for every position of the axis, as found by careful experiment. Soft-iron bar No. 2 was hollow, of the same length and diameter as bar No. 1, and half its weight. It is impórtant that the lengths should correspond, for reasons to be hereafter given. Soft-iron bar No. 3 was of the same diameter as bars 1 and 2, but shorter by two inches.

When bar No. 1 was suspended to the hook of the spring balance, and inserted about half way through helix 1, and the helix connected with the battery, the bar was drawn down into the helix with a force of six pounds, as indicated by the spring balance. This balance is sensitive to the $\frac{1}{25}$ of an ounce, and when dealing with pounds, may be considered as sufficiently accurate. The hollow bar No. 2 was then substituted for bar No. 1, and was drawn down by a force of three pounds and a fraction over, the fraction doubtless arising from some difference in the textures of the two bars. We are thus furnished, by this satisfactory and practical test, with a definite law of inductive action, viz.

The inductive action of a helix upon inclosed bars of soft iron of uniform lengths and transverse diameters, is directly in proportion to the weight of those bars.

The bar No. 3 was then inserted, and it was drawn down by a force of five pounds and one ounce; but here the result became complicated, and will require further trials with many variations of length and also diameter of the soft iron bars. It probably would not follow that the indefinite increase of weight by increase of length would give a proportionate increase of inductive action, for there must soon be a limit for every size of bar, and this limit will vary with the different sizes. The experiments as tried, however, are in favor of the conclusion that the action is as the *mass*, and not the *surface*. One experiment remains yet to be tried in this connexion, for which I have not yet had opportunity, viz. to make the masses the same, and vary the diameters. The result here also would be complicated by the element of the distance.

The second investigation was directed to the law of Ampère, viz. that the action of helices upon a magnetic bar, is inversely as the distance. The same law of course applies to soft iron as to permanent magnets. The law was fully confirmed. Great care was taken in the preparation for these experiments. The helices before mentioned were all wound upon steel mandrels, carefully turned and polished, and all of the same length of wire. The bores of three helices regularly increased in diameter $\frac{1}{20}$ of an inch. When these helices were placed in succession upon a bar of soft iron, they gave by the balance, forces inversely proportional to the distance.

Art. XVIII.—*On the probable Conduction of Galvanic Electricity through Moist Air;* by Chas. G. Page, M. D., Prof. Chem. and Pharm., Columbian College, Washington, D. C.

Seven or eight years since, I observed a curious fact, which led me to the conclusion that many substances considered as perfect insulators, or rather non-conductors of galvanic electricity, might under certain circumstances prove conductors. I took two large sheets of zinc and coiled them together, the two sheets being separated by a layer of India rubber cloth. The sheets of zinc were connected, respectively, with the poles of a battery, and when the battery consisted of a single pair, no appreciable current passed from plate to plate through the India rubber cloth. When however the battery consisted of twenty compound pairs, a slight current passed, as indicated by a delicate galvanoscope. I made no further investigation or application of this fact till 1843, when recurrence was had to this feature to solve some difficulties experienced in the projection of a line of Morse's telegraph between this place and Baltimore. Ten miles of lead pipe containing four well insulated wires had been laid in the ground, and upon trying these wires respectively, making the wire one half of the circuit, and the lead pipe the other half, with a battery of intensity, a current could be established through any one of the three *extra* wires. Being consulted by Prof. Morse as to the probable cause of this *cross firing* as it was technically called, the solution seemed to me to be obvious in view of the above experiment. The reasoning was sufficiently plausible to induce Prof. Morse to abandon the undertaking of the pipe, and resort to his original plan of raising the wire upon posts. The explanation was simply this, viz. that the insulating or non-conducting material would under any circumstances conduct the current; but in some cases, the amount transmitted could not be appreciated by any known test however delicate, was a *postulate* subsequently borne out. Does not such a conclusion follow directly from the law of Pouillet, that the conducting power of wires is directly as their cross section and some inverse ratio of their length, in connexion with the well established laws of the different conducting powers of metals? For example, copper having from four to six times the conducting power of iron, a wire of iron, to equal in this respect a wire of copper, should be of from four to six times the size. Let this rule be applied to poorer conductors, and we may infer that the poorest conductor, or what has been usually considered a non-conductor, would become a conductor, if the area of its cross section were indefinitely increased and its length remained nearly nothing. In the case of the wires in the lead pipe—the one for instance joining the two poles of the battery—is separated from that lying next to it and the lead pipe, by a layer of thin non-conducting material throughout its length; and if we suppose the width of this layer in contact to be $\frac{1}{8}$ of an inch, the length of ten miles would give a surface of 550 square feet, while the length of the conductor would be only the thickness of the material, and a constant quantity, for any length of wires and tube, and increase of surfaces in contact. A full realization of the principle appears in the fact, that although the earth is a much poorer conductor than copper, mass for mass, yet upon the telegraphic routes, it is found that the earth is a much better conductor than the copper wires used, the mass of the former being indefinitely greater than the latter.

These phenomena induced me to try the following experiment, in order to ascertain if the air might not act as a conductor. The roof of the patent office building covered with copper, exposes to the air twenty-two thousand square feet of this metal, and thus affords an enormous surface for conduction. A wire was connected with the metal of the roof, another wire with a plate of zinc of about four square feet. The free ends of these two wires were connected with a galvanoscope of exceeding sensitiveness, and with matters thus arranged, the zinc plate was insulated from the earth and building, in the open air, and when the upper surface of the zinc plate was moistened with water or what proved still better, acidulated water, the needle of the galvanoscope was deflected from two to five degrees. There was a slight drizzling rain at the time. Before the zinc plate was moistened no action was noticed. The inference from this experiment seems safely to warrant the position that a moist atmosphere conducts galvanic electricity. Many years since, I proposed in this Journal a plan for ascertaining the level of the water in steam boilers consisting of a zinc plate or a pair of plates, which should indicate the failure of water in the boiler by the cessation of action upon a galvanoscope placed in any convenient position outside the boiler. I have never had opportunity to test this device, but was at the time somewhat apprehensive that pure steam might act as a conductor and thus defeat the invention. I have recently been informed, though not in a direct manner, that the experiment had been tried in Philadelphia and that the steam acted as a conductor. Whether dry air could act at all as a conductor remains yet to be ascertained, and I shall be able soon, to put it to the test. Immediately after the above experiment was tried, the zinc plate was buried in the earth, other things remaining the same. The galvanoscope is inside a window in the second story, where I am enabled to watch it through most of the day. To my surprise as soon as connexion was made with the plates, one being the copper roofing, and the other buried vertically in the earth, the needle was deflected forty degrees, and the quantity of electricity afforded was sufficient to operate the magnets used in Morse's telegraph, as witnessed by the Professor, and others present. Is the conduction through the material of the building or through the earth and intervening atmosphere? Probably through the mass of the building, which is constructed of blocks of sandstone, the walls being $2\frac{1}{2}$ ft. in thickness. A small piece of this stone was found not to conduct this current perceptibly, either dry or when moistened with water. But when moistened with acidulated water, the current passed feebly. The fact is interesting whether the air or sandstone becomes the conductor; for if the conduction be through the building, it is through a material which in a block of eight or ten cubic inches, is apparently a non-conductor, but which in the aggregate of the immense pile of the edifice is a conductor. The extreme sensitiveness of the galvanoscope is evident from its frequent disturbances from the slightest causes. I may safely say that the needle is affected by a flash of lightning one hundred miles distant. Whenever a thunder cloud is visible, the needle is deflected at each flash of lightning, and the deflection is in one or the other direction, as the induced current varies according to the direction of the lightning. When the thunder cloud is near, the action upon the needle is very strong and has several times twisted it suddenly off from the silken fibre to which it is attached. When no cloud is visible in the horizon, the needle on certain days—particularly at noon when thunder storms most frequently occur—is subject to frequent disturbances, resembling the former. I may remark here, as evidence of the rapidity of induction, the movement of the needle and flash of lightning appear simultaneous to the eye.

There are some extraordinary influences upon the needle, having a kind of periodicity, which cannot yet be accounted for, or identified with any meteorological fluctuations. There are also regular changes, which have thus far been noticed during the day. In the morning the current is at its maximum. About 10 o'clock A. M. it declines, and gets to its minimum about half past 2 P. M., when the needle begins to return and arrives within four or five degrees of its maximum of deflection at 8 P. M. Whether this point observed at 8 A. M. is the real maximum is not known, as I have not been able to observe it in the night. The range of variation from morning to night is about ten degrees. I have not been able to notice any irregularity in these changes except as to the time. The irregular disturbances are very interesting, and may be identical with the *magnetic storms* of Gauss. Upon certain days they are hardly perceptible, though they never cease altogether. On some days they are violent, if I may be allowed the expression. The needle does not take a sudden start and return as when influenced by lightning, but moves gradually without oscillation to some fixed point, from which it will return sometimes in two minutes and sometimes in ten or fifteen minutes. An extended series of observations will be necessary before any deductions can be safely made. If the wires should be separated by a slight interval during a thunder storm, doubtless electrical sparks would be visible. During heavy storms, a flash of lightning twenty miles distant from the wires of Morse's telegraph will induce electricity in the wire sufficient to operate the magnets, and work the telegraph, sometimes recording several signals. A flash of lightning in Baltimore, forty miles distant from this place, will operate the magnet at this end of the line.

Washington, D. C.

Appendix.—Mr. Lane remarks, in his communication on the electric conduction in metals,* that in his experiments he found no confirmation of the statement made in this Journal † a few years since, "that the conducting power of a wire is greatly impaired by bending or twisting it." Mr. Lane has somewhat magnified my meaning by introducing the word *greatly*, which I did not use, and it is probable that he has really confirmed my statement, as he remarks, that after winding and unwinding a thick wire several times over a cylinder less than an inch in diameter, the conducting power appeared scarcely affected, implying that some effect was produced; and if in Mr. Lane's ingenious and well arranged experiments, which were made with only a few feet of wire, he found even the slightest loss of conducting power, it is reasonable to suppose that in many hundred feet of wire the loss would be a very notable quantity. A statement which I also made in addition to the above, should have been explained. The statement was that "a wire which has once been wound upon a magnet is not fit for the same purpose again." There are

* See this Journal, Second Series, i, 230.

† See this Journal, First Series, xxxv, 109.

two reasons why such wire would not answer as well as before. *First*, its conducting power would be impaired, and *secondly*, it is extremely difficult to straighten such wire, so as to wind the several turns as closely as before. In regard to the tables which have heretofore been made for the relative conducting powers of different metals, it must be observed, that they cannot be regarded as any thing more than approximations to the truth. What is true of many practical applications of science, is particularly so of galvanism, viz. that laws, rules, or principles deduced from miniature experiments, have entirely failed when applied to operations upon a large scale. As for instance, the law of Pouillet, that wires conducted directly as their cross sections and inversely as their length, was admitted until the experiments in telegraphic operations upon hundreds of miles of wire, disproved this law and confirmed the law of Ohm. I have some interesting facts hereafter to be communicated, showing the importance of operations upon grand scales, in establishing general principles. Most of your readers will remember the signal discovery of Liebig of the existence and economy of ammonia in the atmosphere, which he owed to his departure from the limited eudiometrical experiments of other philosophers and investigating large quantities of air instead of small. The effect before alluded to of bending and twisting wires is much more apparent in some species of wires than others. There has been a spurious copper wire now for some time in the market, and it has been my misfortune to purchase about ten thousand feet of it.* Its conducting capacity as measured by the *axial galvanometer*, in lengths of 1000 feet, is about one-third less than pure copper wire. It is well known that a wire may soon be broken by bending it back and forth for a few times. Each bend of course approaches to this solution of continuity, and must interrupt that integrity of molecular arrangement which is essential to good conduction. Now a few such short bends may not be appreciable by ordinary tests, but when multiplied several hundred times, the resistance to the current becomes of sufficient moment to be a subject of attention.

C. G. P.

Washington, D. C., July 3d, 1846.

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* It is the same wire that has so perplexed the telegraphic operations between New York and Philadelphia, breaking almost daily merely by its own weight.

Art. XIX.—*Eocene Formation of the Walnut Hills, &c., Mississippi;* by T. A. Conrad.

The elevated bluffs on the Mississippi above New Orleans, on which stand the towns of Natchez, Rodney, Grand Gulf, and Vicksburg have a similar geological origin, and these interesting hills present sections of two formations or depositions widely different in age, as well as in the phenomena presented to our notice and in the causes which produced them. The lower strata are wholly of marine origin, and as I stated in a former publication, they are members of the Eocene, admirably characterized by the peculiar forms which existed in the seas of that period. The shells are extremely abundant, and as in all other localities of the Union which have been explored, the line of demarcation between this formation and the Miocene is as strongly marked as a total diversity of species can make it. My investigations during a late tour in Mississippi, have been chiefly confined to the vicinity of Vicksburg. The hills here rise steeply from the Mississippi river and are some miles in extent. They have been washed into frequent and sometimes very profound ravines which cut through and expose the Eocene strata, and the sides of the hills and ravines are whitened in many places by the shells which have been washed out of the ferruginous marl or fossiliferous mixture of sand and clay. The strata appear to be nearly horizontal and the greatest elevation about sixty feet above the ordinary high-water level. The lowest stratum exposed is a bluish compact limestone, which is quarried for the purpose of paving the streets of Vicksburg. It is full of shells and casts of shells of such species as are common in the marls above. One of the most abundant bivalves is *Pecten Poulsoni*, (Morton,) a species occurring in the white limestone near Claiborne, Alabama. A very thin wafer-shaped Nummulite, described by Dr. Morton, is common in the limestone as well as in all the strata above, and connects the formation of Vicksburg with the Eocene white limestone of St. Stephen's, Alabama. A new species of *Pinna* is one of the most striking fossils of the limestone at Vicksburg, and which is rare above it. Over this rock are various strata of sandy marl, sometimes indurated and ferruginous, clay, and clay and sand mixed, all of which are very prolific in fossil shells.

Near the summit of the Eocene are beds of coarse gravel mixed with whole shells and fragments, from which many fine agates have been procured by Mr. Anderson of Vicksburg. These strata do not appear to have been much disturbed or inclined by the force which elevated them to their present level. The group of fossil shells though as strongly marked in its Eocene character as any in the Union, is yet remarkably distinct from that of Claiborne or of any other locality which I have seen, as out of about sixty-two species, thirty-eight are new, and I am confident that ten species will on comparison be found identical with Claiborne shells. In most of the strata here, small and large fragments of shells are very abundant, some of which are water-worn and others not in the least abraded. Occasionally we find a black water-worn shell just in the proportion to the others as we see them on the sea beach of New Jersey. The vicinity of an ancient sea beach is strongly indicated by the phenomena of these strata, which is not the case at Claiborne. Bivalves with connected valves are rare, fragments abundant, and the many water-worn specimens all tend to prove the action of the surf. In the clay stratum of the upper portion of the formation, the shells in some rare instances retain a trace of their original colors and their polish is fully equal to that of recent shells, though they become chalky on exposure to the sun. The large *Cardita planicosta*, which so generally prevails in Eocene deposits, is unknown here, and the *Crassatella alta* of Claiborne is also absent, but there is an allied though very distinct species. There is one bivalve here, a new *Panopæa* which is common, and yet unlike the other bivalves is almost in every instance entire, and placed vertically in the strata, just as it occurred when living and burrowing in the bed of the sea. It therefore lived and died on the spot where it is now found, whilst nearly every other shell had been abraded by the surf or transported by currents. This is precisely the case with all the various species of *Panopæa* in the Miocene formation, and it is clear that they burrowed deeply in the mud or sand beyond the influence of the agitated waters which scattered the various shells at that time existing near the surface.

The principal development of the Eocene is north of Vicksburg, and every ravine cuts through its various strata, but it is almost impossible to procure an accurate section of them, as they are universally sunk and displaced by land slides and subsidence.

As near as I could ascertain, the Eocene strata rise to a level of sixty feet above the river when there is an ordinary freshet. The limestone, nearly on a level with the water, is the lowest stratum known, as debris and deposits from the river cover and conceal whatever may be at a lower level. At the plantation of Dr. George Smith, five miles northeast of Vicksburg, a ravine cuts through the Eocene strata and exposes about the same elevation of horizontal beds, and between them and the loam with land shells, is a stratum of loam with coarse gravel without a trace of organic remains. This gravel is also visible at Vicksburg, but the thickness of it; or its relation to the Eocene is not yet determined.

The only abundant shell of the Vicksburg Eocene, common also at Claiborne in Alabama, is *Dentalium thalloides*. It is probable that the deposits of the Walnut Hills were made in shoaler water, and nearer the shore of the Eocene ocean than those of Claiborne, but it is remarkable that no species of *Cerithium* occurs, a genus so abundant in species in the Eocene of France, and which is supposed, where it abounds in a fossil state, to indicate an ancient estuary.

Vicksburg Fossiliferous Loam.

Above the Eocene of Vicksburg, Grand Gulf, Rodney and Natchez, there is a thick deposit of loam of uniform composition and appearance, which is at least fifty feet thick in many places, and probably much more in others; but owing to land slides and the vast accumulation of debris between this loam and the Eocene, the depth of the former is uncertain, and there may be a distinct deposit between the two. The loam is apparently identical in composition with the cane-brake lands of the Mississippi, and abounds in land shells of such species as exist plentifully in the alluvial flats subject to the overflow of freshets. I have collected *Helix thyroidus*, *H. ligera*, *H. concava*, *H. setosa*, *H. arborea*, *H. perspectiva*, &c., together with *Succinea ovalis* and *Helicina orbiculata*. Of fresh water shells, there is a small *Cyclas* and *Paludina* which I have not seen in the rivulets near Vicksburg, though two other species of *Cyclas* abound in one of these small streams. The fossiliferous loam has a very undulating summit line, following the outline of the innumerable hills, and it is covered by six to eight feet of a different kind of earth, in which no shells occur. No gravel is mixed with either of these strata, but calcareous concretions abound in the lower stratum of loam with shells. I am indebted to the polite attention of Dr. E. H. Bryan, who resides near the Jackson rail road, nine miles east of Vicksburg, for an opportunity to make some interesting explorations in his vicinity. We visited one of the numerous horseshoe lakes formed by the rivers' deserting old channels and seeking a new course. We passed through a tract of alluvial land still subject to be overflowed, and in one of the rivulets collected two species of *Cyclas* which are not seen in the fossiliferous loam. The land shells, on the contrary, are precisely of such species as abound in it, and occur plentifully under logs and dead leaves in the woods, where they must be subject to be killed by freshets and buried under the deposit left by the retiring waters. Almost as soon as the freshet subsides, another generation of these shells exists here, and thus as the deposition goes on, the land shells are distributed throughout the alluvium to a great depth precisely as they are in the fossiliferous loam of the hills. In the rivulets the Cyclas exists, and is carried out by floods and distributed among the land shells, but they are rare in comparison with the latter both in the fossil and recent state. In the numerous *cut-offs* or lakes *Unios* and *Paludinas* abound, and these are represented in the ancient deposit by the beds of similar shells, all of existing species, which occur in patches everywhere throughout this singular region. They always occur in a black soil, evidently once the bed of lakes, and entirely different in color and consistence from the loam containing land shells, and they are always at a much lower level than the top of the latter deposit. One of these beds of the fossil Unio we observed near Big Black river, which though much below the surface of the hills of fossiliferous loam, is yet at an elevation of about fifty feet above the river when the water is moderately high. Among these shells I noticed *Unio cicatricosus* and *Paludina ponderosa.* In the bluff near Vicksburg and on Dr. Smith's plantation northeast of the town, *Unio quadrulus,* Raf., was the most common species observed. The identity of the fossiliferous loam with the alluvium of the Mississippi, is confirmed by a singular phenomenon in the nearly perpendicular banks formed by cutting through hills on the line of the Jackson railroad. Dr. Bryan called my attention to the willow and cottonwood trees, which have their roots in the summit line of the fossiliferous loam, eight feet beneath the surface of the hills. These are the kinds of trees which first take possession of the soil made by deposition from the Mississippi near its mouths, and which refuse to grow on the hills above the loam or in the earth which overlies it. These trees grow only on the summit line of the loam, following all its undulations, and many are of such a size that they are evidently nearly as old as the excavations which have given them a chance to spring up. The railroad has been made about ten years, and Dr. Bryan assures me that the trees made their appearance soon after the hills were cut through. The seeds or roots must therefore have been in the newest deposits of loam, and it is evident that no vegetation, except canes or reeds, occupied the soil before its latest deposition, at which latter period it is probable that the willow, cottonwood, and other trees, first made their appearance on the earth, and perhaps the mastodon, elephant, hippopotamus, &c., came into existence at the same time, since the remains of the mastodon and elephant have been abundantly found in the vicinity of Natchez and Vicksburg, though I have not ascertained in what part of the stratum they occur. The foregoing facts and observations have led to the inference that all this thick and elevated deposit, with land universally distributed through it, was the result of ancient floods in the Mississippi and its tributaries. The cause, whatever it may have been, which elevated the Eocene strata of the Mississippi bluffs, raised at the same time this ancient alluvium, and thus the uprise of the tertiary may be referred to a very modern period, and one which seems to have been connected with the causes which destroyed the mastodon, elephant, hippopotamus, &c. which once existed in North America. It is difficult to account for the origin of the peculiar earth above the fossiliferous loam, or to assign a cause for the undulations of the surface of the latter, which conforms to the slopes of the innumerable hills in this country, where there is no level ground except that subject to floods from the rivers. It is certain, however, that the lakes are numerous, their shores steep and high, and that a future elevation of the country would present a large proportion of steep declivities, having their origin in the present sloping shores of the cut-off lakes which are common near all the rivers, where they approach the Mississippi.

There seems to be no other theory than the one I have suggested which can account for the origin of the fossiliferous loam.

A lacustrine origin is out of the question, because such an universal diffusion of land shells with no fresh-water shells among them, except *Cyclas* and small *Paludinæ*, could under no circumstances take place in a lake of considerable size. In that case, Unios and large fresh-water shells would be the predominant fossils, and land shells of rare occurrence. Admitting the loam to have been deposited by the overflows of the ancient Mississippi, it assumes a feature of extraordinary interest in proving a considerable elevation of the Eocene strata in a period as recent as that when the mastodon existed. This rise of land, I have no doubt, was coeval with that of the Gnathodon beds of Florida, Alabama, and Louisiana, of the keys of Florida, and of the oyster shell deposits of Virginia, Maryland, and New Jersey. At this time the change of climate occurred which has restricted the living Gnathodon to the estuaries of the Gulf of Mexico, and which was probably connected with the disturbance or revolution that exterminated the mastodon and its gigantic associates.

Art. XX.—*Notice of a small Ornithichnite;* by C. B. Adams, State Geologist of Vermont, &c.

The specimen from which the following figures were drawn, was obtained in Wethersfield, Ct., at the locality of Ornithichnites described in the Final Report on the Geology of Massachusetts, pp. 466–7, and with many others from the same locality, is now in the cabinet of Middlebury College, Vermont. It is a fine red slate of the new red sandstone. The tracks here figured are in relief, the specimen having the corresponding impressions not having come into the possession of the writer.

Fig. 1.

Fig. 1 appears referable to the species *Argoides minimus*, Hitchk.* This animal appears to have had slender toes, but a broad heel, like *Polemarchus gigas*, Hitchk.,† which, as in that case, indicates a much heavier animal than would have been supposed from the slenderness of the toes. These two animals, so

* Proceedings of Sixth Meeting of Association of American Geologists, p. 24.
† Ibid.

extreme in size, may possibly have been more nearly related than has commonly been supposed. The dotted line *a c e* includes the slope of the depression made in the plastic stratum around the heel.

Fig. 2.

But the principal object of this notice is to call attention to the small track, fig. 2. It is near the larger track in the slabs which show their relative position, and is quite moderately depressed. From its general resemblance in form to the other track, it seems probable that it was made by an animal of the same species. The difference in the form of the toes may be readily accounted for by the want of an exact proportion between the width of the toes and that of their tracks, and by differences of the former consequent on difference of age. As the extremities of the impressions of the toes are sharply defined, it cannot be supposed that the track is imperfect in front. The posterior portion of the heel is less distinctly defined, and the whole heel was less deeply impressed, the deepest part of the track being represented by the dotted line *n*. This corresponds with the general character of *Argoides minimus*, as described by Pres. Hitchcock, "heel rarely making an impression"—our fig. 1 representing a track of the heel very remarkable for the depth and size. In pl. 42, fig. 35, of the Final Report above quoted, we see several tracks of the same size with the small specimen, fig. 2, but without the heel. The discovery of the latter in one of these small tracks, strengthens the conclusion that they were made by the *Argoides minimus*.

Art. XXI.—*On the Discoidal Stones of the Indian Mounds*; by E. G. Squier.

In the paper contributed, by Dr. Morton, to the last number of the American Journal of Science,* reference is made to certain "discoidal stones," some of which are figured. Exact counterparts of these stones, are in the possession of Dr. Hildreth of Marietta; in fact, they occur in considerable numbers, all over Ohio, and may be found in the cabinets of almost every collector of aboriginal remains. After extensive exploration, I have reason to think it extremely doubtful whether discs of this description were ever found in the mounds, except in cases when they were depos-

* Second Series, ii, 1.

ited by the modern (existing) race of Indians. The stones met with in a mound near Chillicothe, to which Dr. Morton alludes, are very unlike those figured in his paper, as they are of horn-stone, rudely blocked out, while the others mentioned, are of great symmetry and manifestly the result of much labor.

Nor is there, apparently, much mystery as to the use made of these stones. I am assured, by Rev. Mr. Finley, "the Wyandot Chief," (distinguished for his zealous efforts in christianizing the Indian tribes of Ohio,) that among the tribes with which he was acquainted, stones of this description were much used in a popular game, somewhat resembling our game of "ten pins." A smooth and well packed area of earth was selected, at one extremity of which a small wooden pin was stuck, while the player stationed himself at the other. The point of the game consisted in striking the pin oftenest in a given number of trials. The form of the stones suggests the manner in which they were held and thrown, or, rather, rolled. The concave sides received the thumb and second finger, the forefinger clasping the periphery.

Adair, in his account of the Indians along the gulf,* gives a minute, and graphic account of a game, somewhat analogous to that described by Mr. Finley, in which stones of this description were used. He says:—"The warriors have another favorite game, called *Chungke*; which, with propriety of language, may be called "Running hard labor." They have near their state house, a square piece of ground well cleared, and fine sand is carefully strewn over it, when requisite, to promote a swifter motion to what they throw along the surface. Only one or two on a side, play at this ancient game. They have a stone about two fingers broad at the edge and two spans round; each party has a pole about eight feet long, smooth and tapering at each end, the points flat. They set off abreast of each other, at six yards from the edge of the play ground; then one of them hurls the stone on its edge, in as direct a line as he can, a considerable distance towards the middle of the other end of the square: when they have run a few yards, each darts his pole, anointed with bear's grease, with a proper force, as near as he can guess, in proportion to the motion of the stone, that the end may lie close to the

* "History of the American Indians, particularly those nations adjoining to the Mississippi, East and West Florida, Georgia, &c. by James Adair, London, 1765."

same—when this is the case, the person counts two of the game, and in proportion to the nearness of the poles to the mark, one is counted, unless, by measurement, both are found to be an equal distance from the stone. In this manner the players will keep moving most of the day, at half speed, under the violent heat of the sun, staking their silver ornaments, their nose, finger and ear-rings, their breast, arm and wrist plates, and all their wearing apparel, except that which barely covers their middle. *All the American Indians* are much addicted to this game, which appears to be a task of stupid drudgery; it seems, however, to be of early origin, when their forefathers used diversions as simple as their manners. The hurling stones, they use at present, were, from time immemorial, rubbed smooth on the rocks, and with prodigious labor; they are kept with the strictest religious care, from one generation to another, and are exempt from being buried with the dead. They belong to the town where they are used and are carefully preserved."—*Adair*, p. 402.

Dr. Morton is, I think, mistaken in supposing the occurrence of these stones to be circumscribed. They certainly occur throughout the west, as do also, the spheroidal stones mentioned, which, it is quite evident, were used for similar purposes.

It will be seen, from the above, that Dr. Blanding was right in his suggestion, that these stones were used in the games of the aborigines.

Chillicothe, Ohio, July, 1846.

Art. XXII.—*Chemical Examination of several Natural Waters*;* by B. Silliman, Jr.

It is nearly a year since the analyses here tabulated, were made and published in the document, whose title is given below. No mention however has been made of them in this Journal, and we now propose, to give only the scientific results in a condensed form and with the omission of much detail which was proper to the pages of the 'Report.'

The writer received the water in samples of two or three gallons in well stopped glass bottles, and designated by numbers only. It was supposed that they were all the product of a gran-

* Report of the Water Commissioners, 1845. Boston City Document, No. 41, 8vo. pp. 160, *Appendix*. Report on the Analysis of the Waters, by B. Silliman, Jr.

itic region, which was not however the case. The waters examined were severally as follows.

Water No. 1. From Mystic Pond, near Boston, about 60 rods above the outlet, taken from the surface, 100 to 150 feet from the shore, where the depth was more than 10 feet, collected August 16, 1845.

No. 2. Croton River, N. Y. taken from the upper reservoir, City of New York, near the S. E. corner and near the outlet leading to the distributing reservoir, collected August 25.

No. 3. Spot Pond, taken July 17th, 150 to 200 feet from the proposed outlet of conduit, and from the surface,—over a depth of 13 feet.

No. 4. Schuylkill, Philadelphia, collected Aug. 23d, 100 to 200 feet above the fore-bay in the pool of Fairmount dam.

No. 5. Long Pond, Mass., collected July 19th, from the point of exit of proposed aqueduct, 150 to 200 feet from shore. Taken from the surface where the depth was 10 feet.

No. 6. Charles River, Watertown, Mass., collected July 29th, 150 to 200 feet above the lower dam, in the middle of the stream.

No. 7. Charles River, South Natick, Mass., collected July 22d, in the middle of the pool, and 200 feet above the dam.

No. 8. Spot Pond, Mass., between the island and southeast shore, at 9 and 13 feet depth from the surface, collected Sept. 3d and 6th.

No. 9. Long Pond, Mass., upper division, from a depth of 62 feet, collected Sept. 8th.

No. 10. Spot Pond, Mass., 26 feet depth—same locality as No. 8—collected Aug. 26th.

No. 11. From a well on the premises of James K. Mills, Esq., No. 20 Beacon street, Boston; taken Oct. 13.

In *color and transparency,* these waters range almost exactly, in the order of their numbers. No. 1, being most transparent and No. 10 least so. No 11 was a very clear water. Nos. 8, 9 and partcularly No. 10, were very deep brown colored waters. No. 10 looked like an infusion of tan bark or weak coffee, and had a copious brown precipitate, like hydrate of iron at the bottom. In *taste,* they were generally good and sweet. No. 1 was however brackish and saline, and No. 11, quite nauseous, from the amount of common salt and magnesian and lime salts it contained. The highly colored water, No. 10, was not disagreeable in taste, while No. 2, (the Croton,) had a decidedly swampy flavor.

Numerous animalcules were observed in most of them when first examined and Prof. Baily detected in samples sent to him, nearly all the common forms of soft and hard shelled polygastric infusoria, usually present in the sweet waters of our ponds and rivers. Water which will not support the life of these delicate creatures is not fit for human use. For a list of these, see the copy of his letter in the report in question.

Only Nos. 1 and 11 were decidedly *hard* waters. The others were generally quite soft.

The general course of analysis was in most respects, similar to that usually pursued. A full qualitative examination was first made, to determine the number and comparative abundance of the foreign matters.

This examination showed that the waters were all neutral except, Nos. 5, 6, 9, 10, and 11, which contained an appreciable quantity of crenic and apocrenic acids. The *carbonic acid* was determined by Berzelius's mode, on a separate quantity, and the *sulphuric acid* was subsequently estimated on the same portion. No ammonia was detected in any of them.

The solid contents were determined by evaporation to a small bulk, of a carefully measured standard gallon of each, in capacious glass flasks, and the evaporation was completed in counterpoised capsules of platina or porcelain. The subsequent ignition of these capsules gave us the amount of matters volatile at redness. The ultimate analysis of the solid contents was divided into two parts, that soluble in boiling water, and the insoluble residue.

The *phosphoric acid* was determined by a re-solution of the ammoniacal precipitate of alumina, iron, &c. in pure acetic acid. If an insoluble residue remained, it was collected, weighed, and then separately analyzed to determine with entire certainty the presence of phosphoric acid. For this purpose the supposed phosphates (of alumina and iron) were fused with one part of silica and six parts of pure carbonate of soda, for half an hour, in a crucible of platinum. The fused mass, treated with water, was filtered, and the silicic acid removed from the filtrate by digestion with carbonate of ammonia and evaporation to dryness. The neutralized filtrate was then treated with nitrate of silver, which promptly threw down the characteristic precipitate of yellow tribasic phosphate of silver, blackening by light, and wholly soluble in dilute nitric acid. This is the method advised by Berzelius for the separation of alumina from phosphoric acid, and no better proof can be required of its presence. The occurrence of *phosphoric acid* in water has generally been overlooked, because unsuspected. It has escaped under the general title of alumina and iron, with which it is thrown down on addition of caustic ammonia. It is certainly interesting to observe that a compound indispensable to the full development of the human frame, should be so widely diffused as to be present, in minute quantity, in almost all natural waters. We are less surprised at this fact now than we should have been a few years ago, since we now know that phosphoric acid is found in granite, mica slate, various limestones of all formations, as well as in many simple minerals where it had before been overlooked; the writer has also detected its presence in connection with *fluorine*, in most recent corals and coral limestone*—and Dr. Jackson informs him that in the analyses of sea waters for the Exploring Expedition, he also detected phosphoric acid.† It is also a fact of significant interest, that *silica*, in its soluble modification, should be found as an almost constant ingredient of natural waters.

The *nitric acid* was determined quantitatively, only in one instance, but its presence was very evident in several of these waters, from the rapid deflagration of the residue of evaporation, on ignition. It is worthy of remark that in all cases where this deflagration was observed, the residue was found to be strongly alkaline, and to effervesce on the addition of a dilute acid: the carbonate of soda and potassa being formed from the decomposition of the nitrates and crenates of these bases.

Table I presents the general results of the evaporation of one gallon of each water: and the estimation of the quantity of carbonic and sulphuric acids in the same quantity.

Number of water.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Solid matter in 100,000 parts by weight, ...	50·752	18·714	3·647	9·417	3·168	5·702	4·332	5·308	5·770	10·598	37·85
Grains of solid in 1 gallon,	39·710	10·93	2·13	5·50	1·85	3·40	2·53	3·10	3·37	6·19	51·274
Volatile at redness, . . .	6·02	4·28	0·86	1·24	0·63	0·85	0·86	1·00	1·16	1·58	1·218
Leaving solid matter, . .	33·68	6·66	1·25	4·26	1·22	2·55	1·668	2·10	2·21	4·62	50·055
Of which there was soluble in hot water, ...	32·45	2·49	0·69	0·57	0·53	0·93	0.758	0·79	0·48	0·73	
Insoluble, ...	1·24	4·47	0·56	3·69	0·69	1·62	0·910	1·31	1·73	3·89	
Volume per gallon of carbonic acid, (in cubic inches)	10·313	17·418	9·516	3·879	10·719	5·058	0·464	5·163	4·549	a trace.	35·04
Sul. acid in one gallon, .	·1058	·0055	·00824	·0245	·0044	·010	·00137	·011	·0037	·00246	4·968

* See this Journal, Second Series, i, 189.

† In this connection I may also mention, that my assistant, Mr. T. S. Hunt, has lately at my request, examined the sea waters of Long Island Sound taken up at this place, (New Haven, Ct.) and has found decisive evidence of the presence of phosphoric acid. The quantity operated on was not sufficient (about sixteen gallons) to give evidence of fluorine and boracic acid, which we cannot doubt do exist—but in exceedingly small quantity—in sea waters. We were led to these examinations by the coral analyses before alluded to.

In reconstructing the supposed condition of the various ingredients, found as they *probably* existed in the waters, the rule adopted has been, to follow as nearly as possible the order of affinities of the various elements concerned, and to regard also that partition of acids among bases which undoubtedly obtains in nature. It is indeed the opinion of Berzelius, Rose and other eminent chemists, that the effort to restore with accuracy the precise condition of the elementary combinations concerned in a mineral water, is altogether futile—except in cases of extraordinary simplicity; and that it is the better way to state only the quantities of the various ingredients found, and leave it for the ingenuity of the student to reconstruct them as he finds most convenient. In my analysis of the waters of the Dead Sea I have followed this principle.*

It was however in the present case required, from the popular nature of the report in which these analyses appeared, to state them in the more usual form. Table II shows the reconstructed condition of the analyses of ten of the waters, while No. 11 is presented by itself.

Table II.—Showing the composition of the fixed residuum of one gallon of each water.

	M. P.†	C.	S. P.	S. R.	L. P.	C. R.	C. R.	S. P.	L. P.	S. P.
Number of water, ...	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Chloride of sodium, ...	27·9111	·167	0·3969	·1470	·0323	·1984	·1547	·1553	·2540	·2230
Chloride of potassium, . . .	·1590	. .	. .	. .	·0380					
Chloride of calcium, ...	·1544	·372	. .	. .	·0308	. .	·0420	·0044		
Chloride of magnesium, . .	. .	. .	. .	·0094	·0764	. .	. .	. .	. .	·0144
Chloride of aluminium, . .	. .	·166								
Sulphate of potassa, ...	. .	. .	. .	. .	. .	·0310				
Sulphate of soda, ...	. .	·153	0·2276	. .	. .	·0830	·3816	·1510	·0843	
Sulphate of magnesia, . . .	1·9768	. .	. .	·0570	.1020	·1350	. .	·1290	. .	·0570
Sulphate of lime, ...	·1219	·235	. .	. .	.	·6810 and silica	·2624 and silica	·4940 and silica	·5700 and silica	2·0700 and silica
Sulphate of alumina, . . .	·4478	. .	. .	. .	. .	. .	. .	. .	·0146	
Phosphate of alumina, . . .	.2810	·832	. .	. .	. .	·0830	·0973	·0740	·1700	*trace.*
Alumina, iron, and phosphate do.	. .	. .	0.1081	. .	. .	. .	. .	. .	. .	1·3600
Alumina, ...	. .	. .	. .	. .	·0800					
Silica, ...	·5559	·077	. .	·0800	·0300					
Carbonate of lime, ...	·1698	2·131	0·3722	1·8720	0·2380	·4970	·1610	·0490	·3860	·3410
Carbonate of magnesia, . .	·9894	·662	0·1420	·3510	.0630	·1300	·0399	·1030	·2560	·2930
Carbonate of soda equal to nitrate and carbonate of do., and loss, ...	. .	1·865	. .	1·6436	·5295	·7116	·5291	·9403	·4757	·2816
Total, ...	32·7671	. .	1.2468							
Actual amount after ignition,	33·6833	6·66	1·2500	4.2600	1·2200	2·550	1·6680	2·1000	2.2100	4·62
Loss, ...	·9162	. .	0·0032							

It will be seen that these tables afford us the means of comparing the respective purity of different samples of the same water, taken from various positions and depths. The general result

* American Journal of Science, First Series, xlviii, 10.

† M. P., Mystic Pond.—C., Croton River.—C. R., Charles River.—S. P., Spot Pond.—S. R., Schuylkill River.—L. P., Long Pond.

is, that the surface water of lakes is purer than that taken from some depth. Nos. 3, 8, and 10, also 2, 6, and 7, also 5 and 9, offer illustrations of this remark. The rivers also gather impurities as they draw near their mouths, the water from high up the stream being purest. It will also be seen that the number and proportion of the ingredients vary in the same water. These results were not a little interesting to the writer and his excellent assistant, Mr. Hunt, when after our labors were closed, we were for the first time supplied with the names of the various sources from whence the waters on which we had labored were obtained.

The specific gravities of these waters were taken with a delicate balance, and with every precaution as regards temperature, &c. A glass bottle with a perforated stopper was used for the purpose. The results were in some cases anomalous, giving for some of the waters a density less than that of pure water. But these differences are so infinitesimal as to be easily accounted for by the gaseous matters which these waters contain. The actual differences from the density of pure water at 60°, afforded even by the most dense of the waters examined in this research, affect only the third place of decimals. Thus No. 11 has 87·811 parts of solid matter in a hundred thousand parts of water, or nearly one per centum, yet its gravity differs from pure recently boiled water distilled from glass by only $\frac{1}{0\cdot001126}$. We should not look therefore for a very appreciable increase of gravity in a water containing only three parts of solid matter in a hundred thousand.

Table III shows the specific gravity.

Number of Water,	1	2	3	4	5	6
Specific Gravity,	1·000541	1·000060	1·0000894	1·000016	1·000118	0·999842
Number of Water,	7	8	9	10	11	
Specific Gravity,	1·000062	0·999924	1·000090	0·999967	0·001126	

The water No. 11 (from a well in Boston) proved to be highly saline. One standard quarter gallon of the water was boiled with the previous addition of a known quantity of pure anhydrous carbonate of soda, which threw down, during the progress of the ebullition, all the earths and other bases present, except the soda, converting them of course into carbonates. Then by the well known methods of analysis, the various ingredients were separately determined, and the soda quantitatively. I give subjoined the *actual* quantities obtained for one gallon of the water, without attempting to reconstruct the order of arrangement which we may suppose they had in nature. We found—

Chlorine, ...	11·8084
Sulphuric acid, ...	4·9683
Lime, ...	10·5853
Magnesia, ...	4·3922
Alumina and oxide of iron, ...	·9884
Phosphate of alumina, ...	3·8857
Silica, ...	6·1158
Carbonate of soda, equivalent of / Nitric and crenic acids and loss, ...	7·3209
	50·0550

Both the silica and phosphate of alumina in the analysis of No. 11 were separately analyzed after their weight was recorded, to ascertain their entire purity and freedom from other matters. We also made a series of experiments to determine the action of these waters on metallic lead. The result of these trials was that every water, except No. 2, (Croton,) acted more or less on the lead. Those interested will find these results tabulated in the report before quoted.

In conclusion we may remark, that all natural waters may in a certain sense be properly called *mineral waters*, as they must each possess a specific and peculiar character dependent on the nature and amount of solid matters which they contain, and this must depend ultimately on the geological structure of the country where they are found. It is curious and instructive to see that even those waters which we consider the purest, contain, in a notable quantity, matters which are absolutely indispensable to satisfy the demands of the vegetable world, (and ultimately the animal also;) and when we remember the vast amount of evaporation from the expanded leaves of a full grown forest tree during a single summer day—can we any longer be at fault for a cause sufficient to account in the most satisfactory manner, for the various inorganic constituents of plants? It cannot be doubted that natural waters act a most important part in conveying into the upward current of organic life those inanimate elements, which, from their constant presence in plants, must be of primary importance, although we are at a loss to explain the mode of their action.*

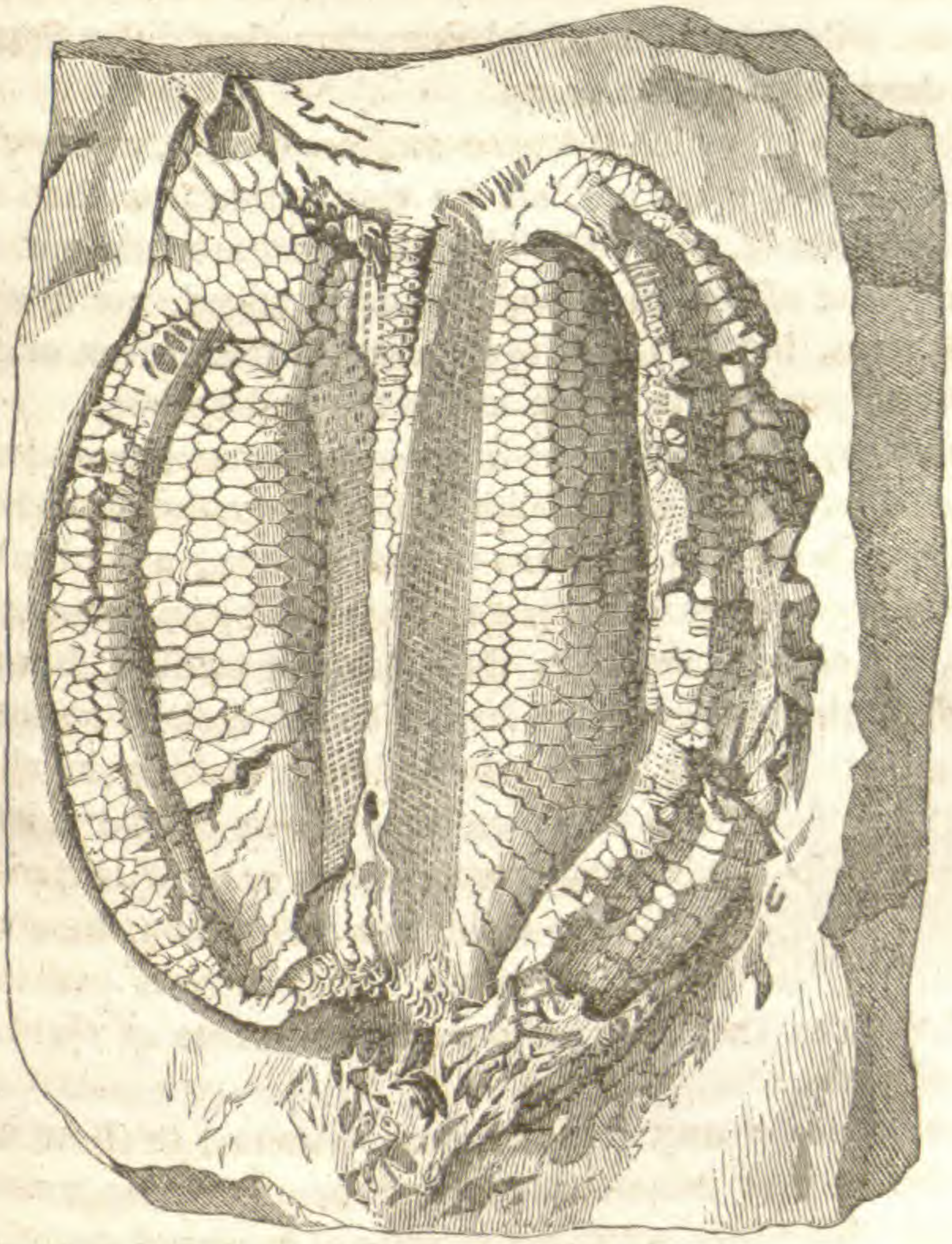
Yale College Laboratory, July 15, 1846.

* The foregoing analyses were made by authority of the city of Boston, preparatory to selecting one of the sources to supply that metropolis. Long Pond (Nos. 5 and 9) was finally chosen.

ART. XXIII.—*Description of a remarkable fossil Echinoderm, from the Limestone Formation of St. Louis, Missouri;* by J. G. NORWOOD, M. D., and D. D. OWEN, M. D.

IN the winter of 1844–5, during a visit to St. Louis, our search after organic remains in that vicinity, was rewarded by the discovery of a slab containing three specimens of a magnificent fossil belonging to the class Radiata, one of which is here represented.

Fig. 1.



Melonites multipora.

A minute inspection of the specimens, induces us to believe that they are gigantic Echinoderms, closely allied to the Echinideans; especially to the Echinus. It is true that in some parts of their anatomy, they differ from Goldfuss's description of that division of the order Echinodermata; yet, it is thought these aberrant characters are hardly sufficient to entitle them to be classed as a distinct group.

With the Echinideans or Echinides of Goldfuss, they agree in three essential characters, viz.: They are composed of ten fields (*areæ*); five broad (*areæ majores*), and five smaller (*areæ ambulacrorum*); and these are made up of little plates, disposed in rows. Pores or holes run in vertical rows up and down the small field (*area ambulacrorum*). There is, moreover, every evidence that the *os inferum* and the *anus* were central, as in the genus Echinus.

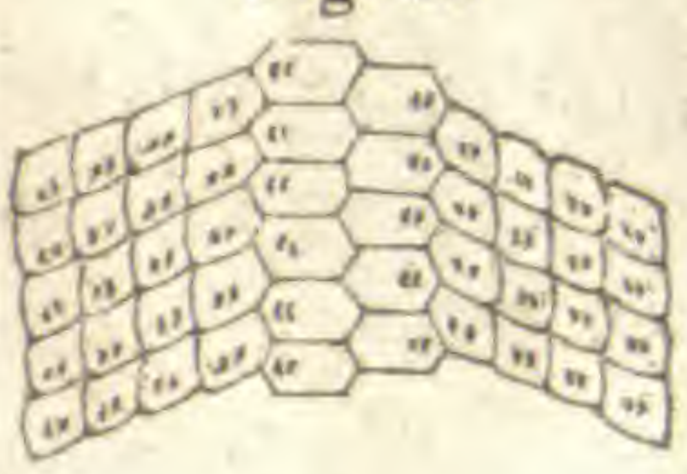
In the following, more trivial characters, they differ from Goldfuss's description of this group.

The plates of which the *areæ majores* consist, are mostly six- instead of five-angled, and are far more numerous than the elementary plates of which Goldfuss's genera are made up.

The plates of the *areæ majores* are arranged, not in single or double rows, but in many rows, varying from seven or eight at the widest part, to five or six at the top and bottom.

The plates constituting the *areæ ambulacrorum* are, doubtless, also more numerous, for, though rather obscurely marked, a close inspection shows that there are two kinds, viz., a double vertical row of elongated hexagonal plates, interlocking and connected laterally, on either side, with three rows of smaller, four-angled, irregularly rhomboidal plates, (very like the eschars on some species of Lepidodendron,) making in all, eight rows of plates, arranged as exhibited in fig. 2; while the corresponding *areæ* of Echinides, according to Goldfuss's description, are composed of but two rows. Each plate is perforated by two holes; so that each *ambulacrum* consists of eight double rows of pores.

Fig. 2.



No evidence of any kind has been obtained to show whether these bodies were pedunculated; but there is strong presumptive evidence that they were not. This is rendered probable, 1st, from their near approximation to the true Echinides; 2d, from their gigantic dimensions; 3d, because no stems have yet been found connected with any of the specimens; 4th, because pedunculated Echinoderms of such vast dimensions, would require a much larger stem than is exhibited by any portions of columns hitherto discovered in this rock; 5th, all the Echinoderms at all approaching the size of this fossil are free bodies; 6th, the absence of a pelvis or circular rim for articulation to a stem; 7th, the presence of depressions in the position, and apparently for performing the offices of the *anus* and *os inferum*.

To sum up, then, with a connected description of the fossil, as far as the specimens in our possession will enable us to do so:—

Body ovoid or nearly spherical, free; *os inferum* central; *anus* central and above; *areæ* ten, five large (*areæ majores*), five small (*areæ ambulacrorum*); *plates* of the areæ majores mostly 6-sided, in many rows; those of the areæ ambulacrorum of two kinds—one set are elongated hexagons, disposed in double vertical rows in the centre of the area, which is elevated into a prominent ridge, along the summit of which the interlocking serrated suture of this double row is situated; the other set smaller, irregularly rhomboidal, and running in oblique rows on either side of the former. Each plate of the areæ ambulacrorum is pierced by two holes; these are central in the rhomboidal plates, but in the hexagonal plates, are situated near the angle furthest from the before mentioned central suture. Each ambulacrum is thus constituted of eight alternating double rows of pores.

Fig. 3.

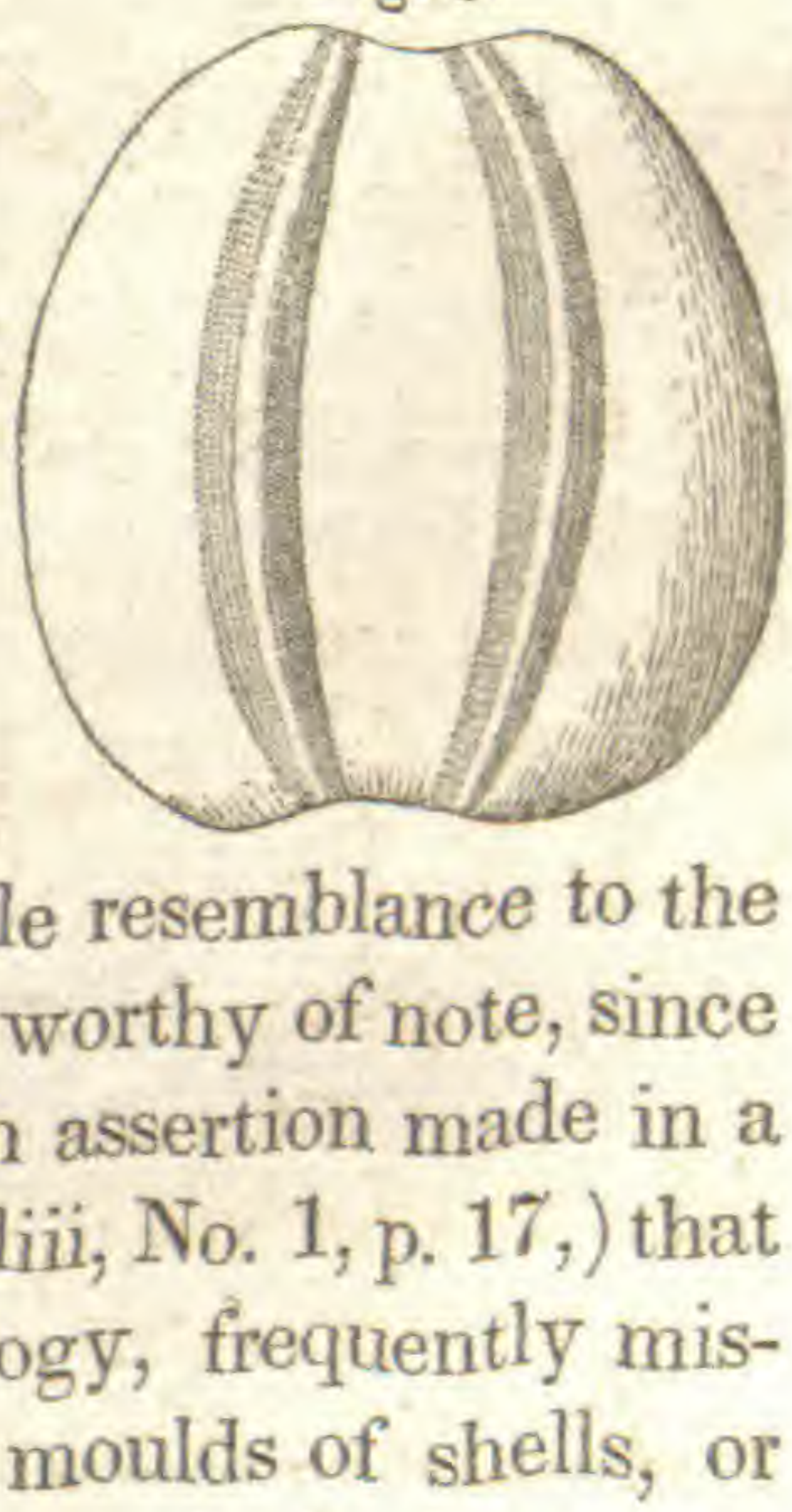


Figure 3, is an outline of a restored representation of the fossil reduced. We propose as an appropriate name for it, *Melonites multipora*, on account of its resemblance, in general outline, to some species of melon, and the great number of pores in the ambulacrum.

This fossil is known amongst the quarrymen, as the "*coltsfoot*." By reference to fig. 1, it will be seen that it bears considerable resemblance to the impress of the frog of a horse's foot. This is worthy of note, since it confirms, in a most remarkable manner, an assertion made in a former number of this Journal, (1st Ser. vol. xliii, No. 1, p. 17,) that those unacquainted with the science of geology, frequently mistake for fossil *footprints*, what are, in fact, moulds of shells, or merely casual appearances. It also warns the geologist how cautious he should be in investigating reported footmarks in solid rock.

The discovery of this fossil is peculiarly interesting, not only on account of its gigantic dimensions, measuring, as it lies on the slab, five and a half inches in vertical diameter, and four and two-tenths in transverse diameter, but, also, as affording additional evidence of the existence of this group of radiated animals at very remote periods.

All the specimens,* hitherto found, were obtained near low water at St. Louis, from a limestone formation, considered the equivalent of the mountain limestone of Europe, associated with the *Producta* figured in vol. xliii, No. 1, p. 81, 1st Ser., of this Journal, an Aulopora, ? *Gorgonia, Retepora, Ceriopora, ?* and a small *Delthyris.*† It is situated, by estimate, from fifty to seventy-five feet below the lowest seam of coal at present known in the great Illinois coal field.

Madison, Ia., June 20, 1846.

Art. XXIV.—*Observations on the Fossil Plants, of the Coal Field of Tuscaloosa, Alabama;* by C. Lyell, Esq., with a description of some species by C. T. F. Bunbury, Esq., F. G. S.

In a former number of the American Journal,‡ I described the geographical position of the coal fields of Alabama, and stated that the carboniferous strata of the Warrior river extend southwards to the town of Tuscaloosa in the neighborhood of which, aided by Professor Brumby, (who had already made some progress in the investigation,) I succeeded in collecting impressions of Sigillaria, Stigmaria, Lepidodendron, Calamites, Neuropteris and several other ferns. I also stated that I recognized a specific identity between several of these fossils, and some of the most abundant coal plants of Pennsylvania and Europe. On my return to England in June, 1846, I submitted the specimens to my friend C. T. F. Bunbury, who immediately compared them with the best published plates and descriptions, and with European fossils in the cabinets of the Geological Society of London. The result of his examination has fully confirmed the conclusion to

* The first specimens of this fossil were found by H. A. Prout, M. D., of St. Louis, sometime previous to our discovery. Most of the specimens yet obtained, are compressed; but Dr. P. has one in his cabinet which is detached, and in the original spheroidal form.

† For want of the necessary works of reference, we are unable, at present, to decide whether these genera, belong to undescribed species.

‡ Second Series, i, 371.

which I had arrived, and it will be seen in the sequel that notwithstanding the loss of several ferns and Sigillariæ which were obtained in a disintegrating matrix near the outcrop of the strata, where the shales are changed into soft, pale, laminated clay, this botanist has been able to detect no less than sixteen forms, of which the following is an enumeration.—1. Sphenopteris latifolia, *Ad. Brongn.* 2. S. Dubuissoni? *Ad. Brongn.* 3. Sphenopteris, allied to the last, perhaps a variety of the same. 4. Neuropteris tenuifolia, *Ad. Brongn.* 5. Neuropteris Grangeri, or N. gigantea? 6. Calamites cannæformis. 7. Calamites, obscure specimen allied to the foregoing. 8. Lepidodendron elegans. 9. Lepidodendron allied to L. dilatatum, *Foss. Flora.* 10. Lepidophyllum? 11. Sigillaria, decorticated. 12. Stigmaria ficoides. 13. Poacites? 14. Bechera tenuis, n. sp., very nearly allied to B. grandis, *Foss. Flora.* 15. Asterophyllites? flaccida. 16. Phyllites, resembling the leaf of Sparganium or Eriocaulon.

The Palæontologist will perceive at once that no less than half of the specimens in the above list, agree with well-known European fossils of the old carboniferous formation, and the rest belong to genera which are common in our coal measures, and may perhaps agree with European fossils when procured in a better state of preservation. The leaves however resembling Sparganium, or still more closely some of the Junci such as Eriocaulon, and which are very abundant, appear to Mr. Bunbury to be new, (see fig. p. 232.)

The three species of Sphenopteris mentioned in the above list all differ from any ferns which I met with in my travels in North America in 1841-2, but one of them S. latifolia is a common Northumberland species found at Newcastle. Neuropteris tenuifolia is also met with at Newcastle, and N. Grangeri occurs in Staffordshire, as also at Zanesville, Ohio. Calamites cannæformis is one of the most abundant forms both in Europe, the United States, and Nova Scotia, and the same may be said of Lepidodendron elegans, the Alabama variety being that commonly met with at Sidney, Cape Breton. Lepidodendron dilatatum is a Northumberland fossil. Lepidopyllum, probably the leaves of the preceding genus, is also a form frequently met with in the British and other European coal strata. The same is true of Stigmaria ficoides, and the genera Stigmaria and Sigillaria are as yet exclusively characteristic of the carboniferous group. Lastly, Bechera tenuis has been found in Coalbrook Dale, Shropshire.

When we recollect that the Tuscaloosa coal field is situated in lat. 33° 10′ North, and that so many of the species now first examined agree with fossils occurring more than twenty degrees farther north in the British Isles, and at a distance of five thousand miles, with a broad ocean intervening, we cannot but be struck with this wide diffusion of a Flora, so singularly uniform in its character. The phenomena seem to imply at the remote period in question the existence, first, of continuous land across the space now occupied by the Atlantic, or at least of a chain of islands in that region; and secondly, a remarkably equable climate; for Dr. Hooker, author of "the Antarctic Flora," has lately observed that no existing Flora, viewed as a whole, preserves so uniform a character for so great a distance in a north and south direction, as that extending from the south of the island of Chiloe to Cape Horn, a range of twelve or thirteen degrees of latitude. This wide distribution occurs where the climate in winter and summer, and throughout the whole year, is peculiarly equable.

Alabama is the most southern spot in the northern hemisphere where the ancient carboniferous flora has yet been studied; geologists therefore will rejoice to hear that Prof. Brumby is fully alive to the importance of a more full investigation of the plants of that country, of which he will soon, it is hoped, have it in his power to form a considerable collection.

Description of Alabama Coal Plants; by C. T. F. Bunbury, Esq.

1. Sphenopteris latifolia. *Ad. Brongn.* Veg. Foss., p. 205, t. 57, f. 1—3. (*Not* of Lindley and Hutton.)

One of these Alabama specimens approaches to S. acutifolia, *Brongn.*, which is probably not distinct from S. latifolia.

2. Sphenopteris Dubuissoni? *Ad. Brongn.* Veg. Foss., p. 195, t. 54, f. 4?

Agrees so nearly with Brongniart's description and figure that I can hardly suppose it to be a different species; the only distinction I perceive, is, that in our plant both the main rachis and that of the primary pinnæ is beset with numerous small protuberances, (forming pits in the impression,) indicating the insertion of hairs or scales, which are not noticed by Brongniart. That author's specimens of S. Dubuissoni were obtained from the coal mines of Montrelais, Loire-Inferieure.

3. Sphenopteris.

Perhaps a variety of the last, or a different stage of growth. The secondary pinnæ however are much longer, the pinnules more distant and more deeply divided, with narrower and more diverging segments.

4. Neuropteris tenuifolia. *Ad. Brongn.*, p. 241, t. 72, f. 3.

5. Neuropteris gigantea? or N. Grangeri?

One or two detached leaflets, scarcely determinable with certainty.

6. Calamites cannæformis. *Ad. Brongn.*, p. 131, t. 21.

7. Calamites.

An obscure specimen, with narrower and more prominent ridges than the foregoing, and no distinct tubercles.

8. Lepidodendron elegans.

The Alabama plant has narrower and more elongated areolæ than the British specimens I have seen of L. elegans, but agrees exactly with specimens from Cape Breton.

9. Lepidodendron.

Decorticated, and very obscure; evidently a large species, with broad rhomboidal areolæ, like L. dilatatum, *Foss. Fl.*

10. Lepidodendron?

Probably the leaves of a Lepidodendron or some nearly allied plant, and much resembling those of L. acerosum, *Foss. Fl.*, t. 8. They are two inches or more in length, narrow, linear, straight, flat, (probably owing to compression,) and marked with a distinct but somewhat irregular ridge or keel along the middle.

11. Sigillaria.

Decorticated and indeterminable.

12. Stigmaria ficoides?

This is doubtless one of the forms which have been commonly comprehended under the name of Stigmaria ficoides; but it is not quite clear that it is either the Stigmaria ficoides or S. Anabathra of Corda. The scars do not exhibit the distinctly umbilicated socket-like appearance observable in the best characterized specimens of these fossils; they appear as if the leaves (or rootlets) had been abruptly broken off, rather than dis-articulated. I have elsewhere noticed the same peculiarity in specimens of Stigmaria from Nova Scotia.

13. Poacites?

Fragments of a broad leaf, rounded at the base, without a midrib, with very numerous, fine, close, apparently simple veins, which diverge at first in a curving manner from the base of the leaf, and then become parallel. No stalk visible.

14. Bechera tenuis (n. sp.?)

This has so close a resemblance to the Bechera grandis, *Lindl. and Hutt. Foss. Fl.*, t. 173, that I am not quite confident of the propriety of considering it a distinct species. It is however a much smaller and more delicate plant, and of a more lax and diffuse habit. I think it safer for the present to treat it as another species, especially since it comes from a locality so very remote. Lindley and Hutton's plant was from Coalbrook Dale.

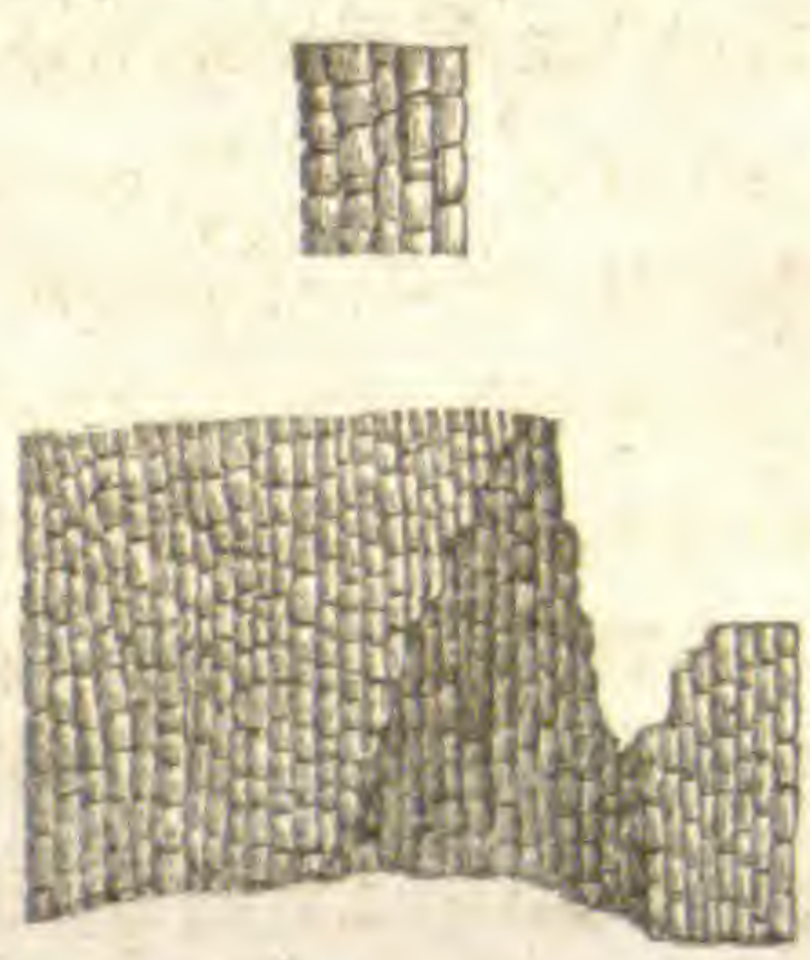
15. Asterophyllites? flaccida.

Fragments, very numerous, but in so unsatisfactory a state as hardly to admit of description. It was probably an aquatic plant, of a very tender and flaccid consistence, with small, verticillate, linear, bluntish leaves, which appear to have no distinct midrib, but several faint longitudinal striæ or veins. In this last peculiarity it departs from the character of Asterophyllites, and it may not be really allied to any of the plants hitherto comprehended under that vague name. It is possible that the apparent leaves may in reality be short branches, and that the plant may have had some affinity to Chara.

16. Phyllites?

In many of the Tuscaloosa specimens there occur, very plentifully, thin layers of vegetable matter, possessing a very remarkable and delicate structure, but without any definite outline that I can discover, so that I remain uncertain whether they are portions of leaves or of flattened stems. Their surface appears, under an ordinary pocket magnifier, most delicately and regularly crossbarred, with strong longitudinal lines and short transverse bars, producing the appearance of a fine net-work, with nearly rectangular meshes, (see the figure.)


Natural size.


Enlarged.

The longitudinal lines or veins, though in general nearly parallel, are by no means accurately so, but are wavy in direction, approximating to one another at uncertain intervals, and occasionally even becoming confluent. This structure somewhat resembles that of the leaves of Sparganium natans, but is far more minute and delicate. It approaches still more closely in texture to the leaves of some species of Eriocaulon.

London, June 30, 1846.

Art. XXV.—*Generality of Magnetic and Diamagnetic Action;* by M. Faraday, Phil. Trans., part i, for 1846, p. 52.

In the last Volume of this Journal, p. 421–425, we gave an abstract of Dr. Faraday's recent researches on magnetic actions. If our limits would permit, we should wish to publish the whole memoir, but must content ourselves with giving the general conclusions with which the distinguished author closes his remarkable researches.—Eds.

2417.* Such are the facts which, in addition to those presented by the phenomena of light, establish a magnetic action or condition of matter new to our knowledge. Under this action, an elongated portion of such matter usually places itself at right angles to the lines of magnetic force; this result may be resolved into the simpler one of repulsion of the matter by either magnetic pole. The set of the elongated portion, or the repulsion of the whole mass, continues as long as the magnetic force is sustained, and ceases with its cessation.

2418. By the exertion of this new condition of force, the body moved may pass either *along* the magnetic lines or *across* them; and it may move along or across them in either or any direction. So that two portions of matter simultaneously subject to this power, may be made to approach each other as if they were mutually attracted, or recede as if mutually repelled. All the phenomena resolve themselves into this, that a portion of such matter, when under magnetic action, tends to move from stronger to weaker places or points of force. When the substance is surrounded by lines of magnetic force of equal power on all sides,

* The numbers are those of Dr. Faraday's Experimental Researches.

it does not tend to move, and is then in marked contradistinction with a linear current of electricity under the same circumstances.

2419. This condition and effect is new, not *only* as it respects the exertion of power by a magnet over bodies previously supposed to be indifferent to its influence, but is *new* as a magnetic action, presenting us with a second mode in which the magnetic power can exert its influence. These two modes are in the same general antithetical relation to each other as positive and negative in electricity, or as northness and southness in polarity, or as the lines of electric and magnetic force in magneto-electricity; and the diamagnetic phenomena are the more important, because they extend largely, and in a new direction, that character of duality which the magnetic force already, in a certain degree, was known to possess.

2420. All matter appears to be subject to the magnetic force as universally as it is to the gravitating, the electric, and the chemical or cohesive forces; for that which is not effected by it in the manner of ordinary magnetic action, is effected in the manner I have now described; the matter possessing for the time the solid or fluid state. Hence substances appear to arrange themselves into two great divisions, the magnetic, and that which I have called the diamagnetic classes; and between these classes the contrast is so great and direct, though varying in degree, that where a substance from the one class will be attracted, a body from the other will be repelled; and where a bar of the one will assume a certain position, a bar of the other will acquire a position at right angles to it.

2421. As yet I have not found a single solid or fluid body, not being a mixture, that is perfectly neutral in relation to the two lists; *i. e.* that is neither attracted nor repelled in air. It would probably be important to the consideration of magnetic action, to know if there were any natural simple substance possessing this condition in the solid or fluid state. Of compound or mixed bodies there may be many; and as it may be important to the advancement of experimental investigation, I will describe the principles on which such a substance was prepared when required for use as a circumambient medium.

2422. It is manifest that the properties of magnetic and diamagnetic bodies are in opposition as respects their dynamic effects; and, therefore, that by a due mixture of bodies from each class, a substance having any intermediate degree of the property of either may be obtained. Protosulphate of iron belongs to the magnetic, and water to the diamagnetic class; and using these substances, I found it easy to make a solution which was neither attracted nor repelled, nor pointed when in air. Such a solution pointed axially when surrounded by water. If made somewhat weaker in respect of the iron, it would point axially in water but equatorially in air; and it could be made to pass more and more into the magnetic or the diamagnetic class by the addition of more sulphate of iron or more water.

2423. Thus a *fluid* medium was obtained, which, practically, as far as I could perceive, had every magnetic character and effect of a gas, and even of a vacuum; and as we possess both magnetic and diamagnetic glass, it is evidently possible to prepare a *solid* substance possessing the same neutral magnetic character.

2424. The endeavor to form a general list of substances in the present imperfect state of our knowledge would be very premature: the one below is given therefore only for the purpose of conveying an idea of the singular association under which bodies come in relation to magnetic force, and for the purpose of general reference hereafter:—*Iron, nickel, cobalt, manganese, palladium, crown-glass, platinum, osmium*—0° *air and vacuum, arsenic, ether, alcohol, gold, water, mercury, flint-glass, tin, heavy-glass, antimony, phosphorus, bismuth.*

2425. It is very interesting to observe that metals are the substances which stand at the extremities of the list, being of all bodies those which are most powerfully opposed to each other in their magnetic condition. It is also a very remarkable circumstance that these differences and departures from the medium condition, are in the metals of the two extremes, iron and bismuth, associated with a small conducting power for electricity. At the same time the *contrast* between these metals, as to their fibrous and granular state, their malleable and brittle character, will press upon the mind whilst contemplating the possible condition of their molecules when subjected to magnetic force.

2426. In reference to the metals, as well as the diamagnetics not of that class, it is satisfactory to have such an answer to the opinion that all bodies are magnetic as iron, as does not consist in a mere negation of that which is affirmed, but in proofs that they are in a different and opposed state, and are able to counteract a very considerable degree of magnetic force (2448).

2427. As already stated, the magnetic force is so strikingly distinct in its action upon bodies of the magnetic and the diamagnetic class, that when it causes the attraction of the one it produces the repulsion of the other; and this we cannot help referring, in some way, to an action upon the molecules or the mass of the substances acted upon, by which they are thrown into different conditions and affected accordingly. In that point of view it is very striking to compare the results with those which are presented to us by a polarized ray, especially as then a remarkable difference comes into view; for if transparent bodies be taken from the two classes, as for instance, heavy glass or water from the diamagnetic, and a piece of green glass or a solution of green vitriol from the magnetic class, then a given line of magnetic force will cause the repulsion of one and the attraction of the other; but this same line of force which thus affects the particles so differently, affects the polarized ray when passing through them precisely in the *same* manner in both cases; for the two bodies cause its rotation in the *same* direction.

2428. This consideration becomes even more important when we connect it with the diamagnetic and the optical properties of bodies which rotate a polarized ray. Thus the iron solution and a piece of quartz, having the power to rotate a ray, point by the influence of the *same* line of magnetic force, the one axially and the other equatorially; but the rotation which is impressed on a ray of light by these two bodies, as far as they are under the influence of the same magnetic force, is the *same* for both. Further, this rotation is quite independent of, and quite unlike that of the quartz in a most important point; for the quartz by itself can only rotate the ray in one direction, but under the influence of the magnetic force it can rotate it both to the right and left, according to the course of the ray. Or, if two pieces of quartz (or two tubes of oil of turpentine) be taken which can rotate the ray *different* ways, the further rotative force manifested by them when under the dominion of the magnetism is always the *same* way; and the direction of that way may be made either to the right or left in either crystal of quartz. All this time the *contrast* between the quartz as a diamagnitic, and the solution of iron as a magnetic body remains undisturbed. Certain considerations regarding the character of a ray, arising from these contrasts, press strongly on my mind, which, when I have had time to submit them to further experiment, I hope to present to the Society.

2429. Theoretically, an explanation of the movements of the diamagnetic bodies, and all the dynamic phenomena consequent upon the action of magnets on them, might be offered in the supposition that magnetic induction caused in them a contrary state to that which it produced in magnetic matter; *i. e.* that if a particle of each kind of matter were placed in a magnetic field both would become magnetic, and each would have its axis parallel to the resultant of magnetic force passing through it; but the particle of magnetic matter would have its north and south poles opposite, or facing towards the contrary poles of the inducing magnet, whereas with the diamagnetic particles the reverse would be the case; and hence would result approximation in the one substance, recession in the other.

2430. Upon Ampère's theory, this view would be equivalent to the supposition, that as currents are induced in iron and magnetics parallel to those existing in the inducing magnet or battery wire; so in bismuth, heavy glass, and diamagnetic bodies, the currents induced are in the contrary direction. This would make the currents in diamagnetics the same in direction as those which are induced in diamagnetic conductors at the *commencement* of the inducing current; and those in magnetic bodies the same as those produced at the *cessation* of the same inducing current. No difficulty would occur as respects non-conducting magnetic and diamagnetic substances, because the hypothetical currents are supposed to exist not in the mass, but round the particles of the matter.

2431. As far as experiment yet bears upon such a notion, we may observe, that the known inductive effects upon masses of magnetic and diamagnetic metals *are the same.* If a straight rod of iron be carried across magnetic lines of force, or if it, or a helix of iron rods or wire, be held near a magnet, as the power in it rises electric currents are induced, which move through the bars or helix in certain determinate directions. If a bar or a helix of bismuth be employed under the same circumstances, the currents are again induced, and precisely in the same direction as in the iron, so that here no difference occurs in the direction of the induced current, and not very much in its force, nothing like so much indeed as between the current induced in either of these metals and a metal taken from near the neutral point. Still there is this difference remaining between the conditions of the experiment and the hypothetical case; that in the former the induction is manifested by currents in the masses, whilst in the latter, *i. e.* in the special magnetic and diamagnetic effects, the currents, if they exist, are probably about the particles of the matter.

2432. The magnetic relation of aëriform bodies is exceedingly remarkable. That oxygen or nitrogen gas should stand in a position intermediate between the magnetic and diamagnetic classes; that it should occupy the place which *no* solid or liquid element can take; that it should show no change in its relations by rarefaction to any possible degree, or even when the space it occupies passes into a vacuum; that it should be the same magnetically with any other gas or vapor; that it should not take its place at one end but in the very middle of the great series of bodies; and that all gases or vapors should be alike, from the rarest state of hydrogen to the densest state of carbonic acid, sulphurous acid, or ether vapor, are points so striking as to persuade one at once that air must have a great and perhaps an active part to play in the physical and terrestrial arrangement of magnetic forces.

2433. At one time I looked to air and gases as the bodies which, allowing attenuation of their substance without addition, would permit of the observation of corresponding variations in their magnetic properties; but now all such power by rarefaction appears to be taken away; and though it is easy to prepare a liquid medium which shall act with other bodies as air does (2422), still it is not truly in the same relation to them; neither does it allow of dilution, for to add water or any such substance is to add to the diamagnetic power of the liquid; and, if it were possible to convert it into vapor and so dilute it by heat, it would pass into the class of gases and be magnetically undistinguishable from the rest.

2434. It is also very remarkable to observe the apparent disappearance of magnetic condition and effect when bodies assume the vaporous or gaseous state, comparing it at the same time with the similar relation to light; for as yet no gas or vapor has been made to show any magnetic influence over the polarized ray, even by the use of powers far more than enough to manifest such action freely in liquid and solid bodies.

2435. Whether the negative results obtained by the use of gases and vapors depend upon the smaller quantity of matter in a given volume, or whether they are direct consequences of the altered physical condition of the substance, is a point of very great importance to the theory of magnetism. I have imagined, in elucidation of the subject, an experiment with one of M. Cagniard de la Tour's ether tubes, but expect to find great difficulty in carrying it into execution, chiefly on account of the strength, and therefore the mass of the tube necessary to resist the expansion of the imprisoned heated ether.

2436. The remarkable condition of air and its relation to bodies taken from the magnetic and diamagnetic classes, causes it to point equatorially in the former and axially in the latter. Or, if the experiment presents its results under the form of attraction and repulsion, the air moves as if repelled in a magnetic medium and attracted in a medium from the diamagnetic class. Hence it seems as if the air were magnetic when compared with diamagnetic bodies, and of the latter class when compared to magnetic bodies.

2437. This result I have considered as explained by the assumption that bismuth and its congeners are absolutely repelled by the magnetic poles, and would, if there were nothing else concerned in the phenomena than the magnet and the bismuth, be equally repelled. So also with the iron and its similars, the attraction has been assumed as a direct result of the mutual action of them and the magnets; further, these actions have been admitted as sufficient to account for the pointing of the air both axially and equatorially, as also for its apparent attraction and repulsion; the effect in these cases being considered as due to the travelling of the air to those positions which the magnetic or diamagnetic bodies tended to leave.

2438. The effects with air are, however, in these results precisely the same as those which were obtained with the solutions of iron of various strength, where *all* the bodies belonged to the magnetic class, and where the effect was evidently due to the greater or smaller degree of magnetic power possessed by the solutions. A weak solution in a stronger pointed equatorially and was repelled like a diamagnetic, not because it did not tend by attraction to an axial position, but because it tended to that position with less force than the matter around it; so the question will enter the mind, whether the diamagnetics, when in air, are repelled and tend to the equatorial position for any other reason, than that the air is more magnetic than they are, and tends to occupy the axial space. It is easy to perceive that if all bodies were magnetic in different degrees, forming one great series from end to end, with air in the middle of the series, the effects would take place as they do actually occur. Any body from the middle part of the series would point equatorially in the bodies above it and axially in those beneath it; for the matter which, like bismuth, goes from a strong to a weak point of action, may do so only because that substance, which is already at the place of weak action, tends to come to the place where the action is strong; just as in electrical induction the bodies best fitted to carry on the force are drawn into the shortest line of action. And so air in water, or even under mercury, is, or appears to be, drawn towards the magnetic pole.

2439. But if this were the true view, and air had such power amongst other bodies as to stand in the midst of them, then one would be led to expect that rarefaction of the air would affect its place, rendering it, perhaps, more diamagnetic, or at all events altering its situation in the list. If such were the case, bodies that set equatorially in it in one state of density, would, as it varied, change their position, and at last set axially: but this they do not do; and whether the rarefied air be compared with the magnetic or the diamagnetic class, or even with dense air, it keeps its place.

2440. Such a view also would make mere space magnetic, and precisely to the same degree as air and gases. Now though it may very well be, that space, air and gases, have the same general relation to magnetic force, it seems to me a great additional assumption to suppose that they are all absolutely magnetic, and in the midst of a series of bodies, rather than to suppose that they are in a normal or zero state. For the present, therefore, I incline to the former view, and consequently to the opinion that diamagnetics have a specific action, antithetically distinct from ordinary magnetic action, and have thus presented us with a magnetic property new to our knowledge.

2441. The amount of this power in diamagnetic substances seems to be very small, when estimated by its dynamic effect, but the motion which it can generate is perhaps not the most striking measure of its force; and it is probable that when its nature is more intimately known to us, other effects produced by it and other indicators and measurers of its powers, than those so imperfectly made known in this paper, will come to our knowledge; and perhaps even new classes of phenomena will serve to make it manifest and indicate its operation. It is very striking to observe the feeble condition of a helix when alone, and the astonishing force which, in giving and receiving, it manifests by association with a piece of soft iron. So also here we may hope for some analogous development of this element of power, so new as yet to our experience. It cannot for a moment be supposed, that, being given to natural bodies, it is either superfluous or insufficient, or unnecessary. It doubtless has its appointed office, and that, one which relates to the whole mass of the globe; and it is probably because of its relation to the whole earth, that its amount is necessarily so small (so to speak) in the portions of matter which we handle and subject to experiment. And small as it is, how vastly greater is this force, even in dynamic results, than the mighty power of gravitation, for instance, which binds the whole universe together, when manifested by masses of matter of equal magnitude!

2442. With a full conviction that the uses of this power in nature will be developed hereafter, and that they will prove, as all other natural results of force do, not merely important but essential, I will venture a few hasty observations.

2443. Matter cannot thus be affected by the magnetic forces without being itself concerned in the phenomenon, and exerting in turn a due amount of influence upon the magnetic force. It requires mere observation to be satisfied that when a magnet is acting upon a piece of soft iron, the iron itself, by the condition which its particles assume, carries on the force to distant points, giving it direction and concentration in a manner most striking. So also here the condition which the particles of intervening diamagnetics acquire, may be the very condition which carries on and causes the transfer of force through them. In former papers* I proposed a theory of electrical induction founded on the action of contiguous particles, with which I am now even more content than at the time of its proposition: and I then ventured

* Philosophical Transactions, 1838, Part I.

to suggest that probably the lateral action of electrical currents which is equivalent to electrodynamic or *magnetic* action, was also conveyed onwards in a similar manner. At that time I could discover no peculiar condition of the intervening or diamagnetic matter; but now that we are able to distinguish such an action, so *like* in its nature in bodies so *unlike* in theirs, and by that so like in character to the manner in which the magnetic force pervades all kinds of bodies, being at the same time as universal in its presence as it is in its action; now that diamagnetics are shown not to be indifferent bodies, I feel still more confidence in repeating the same suggestion, and asking whether it may not be by the action of the contiguous or next succeeding particles that the magnetic force is carried onwards, and whether the peculiar condition acquired by diamagnetics when subject to magnetic action, is not that condition by which such propagation of the force is affected?

2444. Whichever view we take of solid and liquid substances, whether as forming two lists, or one great magnetic class (2424, 2437), it will not, as far as I can perceive, affect the question. They are all subject to the influence of the magnetic lines of force passing through them, and the virtual difference in property and character between any two substances taken from different places in the list (2424,) will be the same; for it is the differential relation of the two which governs their mutual effects.

2445. It is that group which includes air, gases, vapours, and even a vacuum which presents any difficulty to the mind; but here there is such a wonderful change in the physical constitution of the bodies, and such high powers in some respects are retained by them, whilst others seem to vanish, that we might almost expect some peculiar condition to be assumed in regard to a power so universal as the magnetic force. Electric induction being an action through distance, is varied enough amongst solid and liquid bodies; but, when it comes to be exerted in air or gases, where it most manifestly exists, it is alike in amount in all; neither does it vary in degree in air however rare or dense it may be. Now magnetic action may be considered as a mere function of electric force, and if it should be found to correspond with the latter in this particular relation to air, gases, &c., it would not excite in my mind any surprise.

2446. In reference to the manner in which it is possible for electric force, either static or dynamic, to be transferred from particle to particle when they are at a distance from each other, or across a vacuum, I have nothing to add to what I have said before. The supposition that such can take place, can present nothing startling to the mind of those who have endeavored to comprehend the radiation and the conduction of heat under one principle of action.

2447. When we consider the magnetic condition of the earth as a whole, without reference to its possible relation to the sun, and reflect upon the enormous amount of diamagnetic matters which, to our knowledge, forms its crust; and when we remember that magnetic curves of a certain amount of force and universal in their presence, are passing through these matters and keeping them constantly in that state of tension, and therefore of action, which I hope successfully to have developed, we cannot doubt but that some great purpose of utility to the system, and to us its inhabitants, is thereby fulfilled, which now we shall have the pleasure of searching out.

2448. Of the substances which compose the crust of the earth, by far the greater portion belongs to the diamagnetic class; and though ferruginous and other magnetic matters, being more energetic in their action, are consequently more striking in their phenomena, we should be hasty in assuming that therefore they overrule entirely the effect of the former bodies. As regards the ocean, lakes, rivers, and the atmosphere, they will exert their peculiar effect almost uninfluenced by any magnetic matter in them; and as respects the rocks and mountains, their diamagnetic influence is perhaps greater than might be anticipated. I mentioned that, by adjusting water and a salt of iron together, I obtained a solution inactive in air (2422); that is, by a due association of the forces of a body from each class, water and a salt of iron, the magnetic force of the latter was entirely counteracted by the diamagnetic force of the former, and the mixture was neither attracted nor repelled. To produce this effect, it required that more than 48·6 grains of crystallized protosulphate of iron should be added to ten cubic inches of water (for these proportions gave a solution which still set equatorially), a quantity so large, that I was greatly astonished on observing the power of the water to overcome it. It is not therefore at all unlikely that many of the masses which form the crust of this our globe may have an excess of diamagnetic power and act accordingly.

2449. Though the general disposition of the magnetic curves which permeate and surround our globe resemble those of a very short magnet, and therefore give lines of force rapidly diverging in their general form, yet the magnitude of the system prevents us from observing any diminution of their power within small limits; so that probably any attempt on the surface of the earth to observe the tendency of matter to pass from stronger to weaker places of action would fail. Theoretically, however, and at first sight, I think a pound of bismuth or of water, estimated at the equator, where the magnetic needle does not dip, ought to weigh less when taken into latitudes where the dip is considerable; whilst a pound of iron, nickel, or cobalt, ought, under the same change of circumstances, to weigh more. If such should really prove to be the case, then a ball of iron and another of bismuth, attached to the ends of a delicate balance beam, should cause that beam to take different inclinations on different parts of the surface of the earth; and it does not seem quite impossible that an instrument to measure one of the conditions of terrestrial magnetic force might be constructed on such a principle.

2450. If one might speculate upon the effect of the whole system of curves upon very large masses, and these masses were in plates or rings, then they would, according to analogy with the magnetic field, place themselves equatorially. If Saturn were a magnet as the earth is, and his ring composed of diamagnetic substances, the tendency of the magnetic forces would be to place it in the position which it actually has.

2451. It is a curious sight to see a piece of wood, or of beef, or an apple, or a bottle of water repelled by a magnet, or taking the leaf of a tree and hanging it up between the poles, to observe it take an equatorial position. Whether any similar effects occur in nature among the myriads of forms which, upon all parts of its surface, are surrounded by air, and are subject to the action of lines of magnetic force, is a question which can only be answered by future observation.

2452. Of the interior of the earth we know nothing, but there are many reasons for believing that it is of a high temperature. On this supposition I have recently remarked, that at a certain distance from the surface downwards, magnetic substances must be entirely destitute, either of the power of retaining magnetism, or becoming magnetic by induction from currents in the crust or otherwise.* This is evidently an error; that the iron, &c. can retain no magnetic condition of itself, is very probably true, but that the magnetic metals and all their compounds retain a certain degree of power to become magnetic by induction, whatever their temperature, has now been proved. The deep magnetic contents of the earth, therefore, though they probably do not constitute of themselves a central magnet, are just in the condition to act as a very soft iron core to the currents around them, or other inducing actions, and very likely are highly important in this respect. What the effect of the diamagnetic part may be under the influence of such inductive forces, we are not prepared to state; but as far as I have been able to observe, such bodies have not their power diminished by heat.

2453. If the sun have anything to do with the magnetism of the globe, then it is probable that part of its effect is due to the action of the light that comes to us from it; and in that expectation the air seems most strikingly placed round our sphere, investing it with a transparent diamagnetic, which therefore is permeable to his rays, and at the same time moving with great velocity across them. Such conditions seem to suggest the possibility of magnetism being there generated; but I shall do better to refrain from giving expression to these vague thoughts (though they will press in upon the mind), and first submitting them to rigid investigation by experiment, if they prove worthy, then present them hereafter to the Royal Society.

Art. XXVI.—*Caricography;* by Prof. C. Dewey, M. D. and D. D.

(Appendix, continued from Vol. xlix, First Series, p. 48.)

No. 199. *C. flaccosperma*, Dew.

Spicis distinctis; staminifera unica cylindracea, squamam oblongam obtusam ferente; pistilliferis 3–6 *tristigmaticis*, oblongis cylindraceis, sublaxifloris, bracteatis, superiore subsessile, inferioribus exserte pedunculatis, suberectis, subremotis; fructibus ovatis, oblongis, subobtusis, minute nervosis, lævibus, subinflatis, ore inte-

* Philosophical Magazine, 1845, vol. xxvii, p. 3.

gro vel emarginato, squamam ovatam acutam duplo vel triplo longioribus; culmis pedalibus glaucis.

Culm a foot high, smooth, leafy towards the base; leaves lanceolate, 3 to 4 lines broad, glaucous, smooth, shorter below; staminate spike short cylindric with an oblong and obtuse scale; pistillate spikes 3 to 6 with *three* stigmas, long and cylindric, suberect and loose-flowered, the lower ones exsertly pedunculate with long leafy bracts and shortish sheaths; fruit oblong-ovate, obtuse or emarginate, slightly nerved, a little inflated; pistillate scale ovate acute and about one-third as long as the fruit; culm and leaves smooth and glaucous.

Florida and Louisiana, Dr. Leavenworth; has a remote resemblance to *C. granularis*, Muh.

No. 200. *C. Leavenworthii*, Dew.

Spiculis ovatis aggregatis 3–5, superne staminiferis sessilibus, sqamo-bracteatis; fructibus ovatis, compressis, superne convexis, acutis, brevirostratis, distigmaticis, ore integris, brevibus, glabris, squama ovato-acuta vix duplo longioribus; culmis tenuibus basi foliaceis.

Culm 6–12 inches high, erect, slender, triquetrous, leafy below the middle; leaves linear, narrow and slender, flat, often longer than the culm, shorter towards the root; spikelets aggregated into a head, staminate above; staminate scales lanceolate; fruit short-ovate, convex above, short-rostrate, smooth, with an ovate and acute scale shorter than the fruit; under the spikelets is a bract or ovate scale passing into a long cusp or awn.

Louisiana, Dr. Leavenworth. From the kindred species, as *C. rosea*, *C. retroflexa*, *C. disperma*, it is readily distinguishable. It closely resembles Tab. Ee, fig. 91, Schk., and called by him a variety of *C. muricata;* but from this our plant is separated far by its fruit and scale.

No. 201. *C. Crawei*, Dew.

Spicis staminiferis 1–3, sæpius unica, oblongis cylindraceis, superiore multo longiore et rarissima apicem fructifera, cum squamis oblongis densis brevi-acutis; pistilliferis 3–6 oblongo-cylindraceis, *tristigmaticis*, subsessilibus vel exserte pedunculatis, densifloris, remotis, vel subaggregatis, infima subradicali et longo-pedunculata; fructibus ovatis teretibus vel conicis, subtriquetris, trinervosis, glabris, vix rostratis, ore integris, squama ovata obtusa vel subacuta duplo longioribus.

Culm 4–10 inches high, triquetrous, oblique, stiff, leafy at the base; bracts sheathing, leafy and long, striate; staminate one, oblong, cylindric, often with one or two more, at or near the base and much shorter, the highest is very rarely pistillate at the summit, and the scales are oblong, obtusish, close, tawny; pistillate spikes 3–6, oblong, cylindric, nearly an inch long or more, densely flowered, erect, remote or near, highest nearly sessile, the middle exsertly pedunculate, the lowest subradical and often very long pedunculate; fruit ovate, conic, subtriquetrous, glabrous, very slightly rostrate, orifice entire; scales of the fruit ovate, obtuse, sometimes acutish, half as long as the fruit; plant pale green, and glabrous; leaves linear, flat, striate, often very short, sometimes half length of culm.

Found at Watertown, and Griffin's Bay, Jefferson Co., N. Y.—Dr. Crawe, whose name it bears. It is too remote from *C. granularis*, and *C. conoidea*, Schk., to be confounded with them.

No. 202. *C. Knieskernii*, Dew.

Spica staminifera unica cylindracea longa pedunculata, squamis oblongis obtusis conferta; spicis pistilliferis ternis, *tristigmaticis*, longo-cylindraceis, sublaxifloris, subdistantibus, subrecurveo-pedunculatis, basi vaginatis; fructibus ovatis, oblongis, subtriquetris, terete-conicis, rostratis, brevi-bidentatis, squama ovata oblonga obtusiuscula brevi-mucronata paulo longioribus; foliis bracteisque minute pubescentibus.

Culm a foot or more high, erect, leafy towards the base, sheaths partly inclosing the peduncles long and leafy, and with the leaves slightly pubescent; staminate spike commonly long and cylindric with oblong and obtuse scales; stigmas three; pistillate spikes three, long and cylindric, rather loose-flowered, long recurved pedunculate; fruit ovate, oblong, tapering above into a beak, bidentate, subtriquetrous; pistillate scale ovate, oblong, obtusish, often slightly mucronate, white and hyaline with a green keel; plant pale green, reddish at the base.

In woods near Oriskany, Dr. Knieskern. Since found near Rome, and near the former locality by Mr. Vasey. It is closely related to *C. sylvatica*, and has been confounded with *C. arctata*, Boott, from both which it is clearly different; from *C. Sullivantii*, Boott, it is far separated.

The name is proposed by Mr. Vasey in honor of Dr. Knieskern, well known as a botanist.

No. 203. *C. Halei*, Dew.

Spica decomposita subpaniculata magna inferne ramosa; spiculis ovatis, aggregatis, plurimis compactis, superne staminiferis, sessilibus; fructibus brevi-ovatis, *distigmaticis*, perlongo-rostratis, nervosis, divergentibus, convexo-concavis, squama ovata acuta triplo longioribus; culmis foliaceis et cum foliis scabris.

Culm 18–30 inches high, triquetrous, rough on the edges, erect, leafy towards the base; leaves long, scabrous on the edges, surpassing the culm and striate; spike compounded of many sets of spikelets, ovate and aggregated and staminate at the apex; stigmas two; fruit short ovate with a very long slender beak, nerved and small, beak very scabrous on the edges; pistillate scale ovate, acute, hyaline on the edges, and scarcely one third the length of the fruit; plant light green; lower part of the spike subpaniculate.

Louisville, Ky., Dr. Short; swamps of Mississippi river in Louisiana, Dr. Leavenworth and Dr. Hale. Confounded with *C. stipata*, from which it is clearly distinguished by its fruit and scale. In *C. stipata* the fruit is a regular taper from the base to the vertex or has a triangular outline, and its form is entirely different from this, as well as the relative length of the beak and the scale.

No. 204. *C. heterostachya*, Torr. in literis.

Spica staminifera unica cylindracea pedunculata, cum squamis oblongis obtusis conferta; spicis pistilliferis 2–4, tristigmaticis, cylindraceis, stricto-floris erectis, raro apice staminiferis, superiore incluso-bracteatis, inferioribus remotis vel perremotis, exserte pedunculatis, brevi-vaginatis; fructibus brevi-ovatis, conicis, subtriquetris, nervosis, ore integris, squama ovata acuta paulo longioribus; foliis lineari-lanceolatis subradicalibus, bracteis lanceolatis foliosis.

Culm 4–8 inches high, erect, slightly triquetrous, stiff, leafy at the base, with broad leafy bracts; staminate spike single, long pedunculate, with oblong and obtuse scales white on the edges and brown on the back; pistillate spikes 2–4, about three, cylindric, rather close-flowered, rather distant, with peduncles partly inclosed in the sheaths, the upper nearly sessile; stigmas three; fruit short-ovate, conic, nerved, entire at the orifice; pistillate scale ovate, acute, a little shorter than the fruit, the lower sometimes mucronate and about the length of the fruit; plant light green; bracts much wider than the leaves and lanceolate.

Drummond Island in Lake Huron, Dr. Torrey; Macomb Co., Michigan, Dr. Cooley. A distinct species.

No. 205. *C. Woodii*, Dew.

Spica staminifera unica, triquetra, oblongo-cylindracea, squamo-bracteata, cum squamis oblongis obtusis densis; pistillifera *tristigmatica*, unica, interdum binæ, ovato-oblonga, laxiflora, superiore exserte pedunculata, erecta, inferiore remota, perlongo-pedunculata, recurva laxa; fructibus obovatis, obtusis subtriquetris, ore strictis erostratis, inferne teretibus, squama ovata subacuta duplo-longioribus; culmo tereti laxo, foliis angustis linearibus striatis; foliis et culmis exigue pubescentibus.

Culm a foot or more high, slender, triquetrous, lax, striate; leaves of the culms short, striate and subradical, but of the roots very long, slender, flat; staminate spike single, triquetro-cylindric, oblong, an inch long, with oblong and obtuse tawny scales, the lowest subbracteate; pistillate spike, 1–2, ovate, short, loose-flowered, upper one sheathed and exsertly pedunculate, the lower very long pedunculate and lax; fruit obovate, obtuse, triquetrous, orifice closed, tapering below, with its scale ovate acutish and half as long as the fruit, and white with a green keel; plant light green, and very slightly pubescent.

Found by Drs. Crawe and Wood on Perch Lake and Peck River, Jefferson Co., N. Y., and named after one of its discoverers, Dr. Wm. A. Wood. It appears to be very distinct.

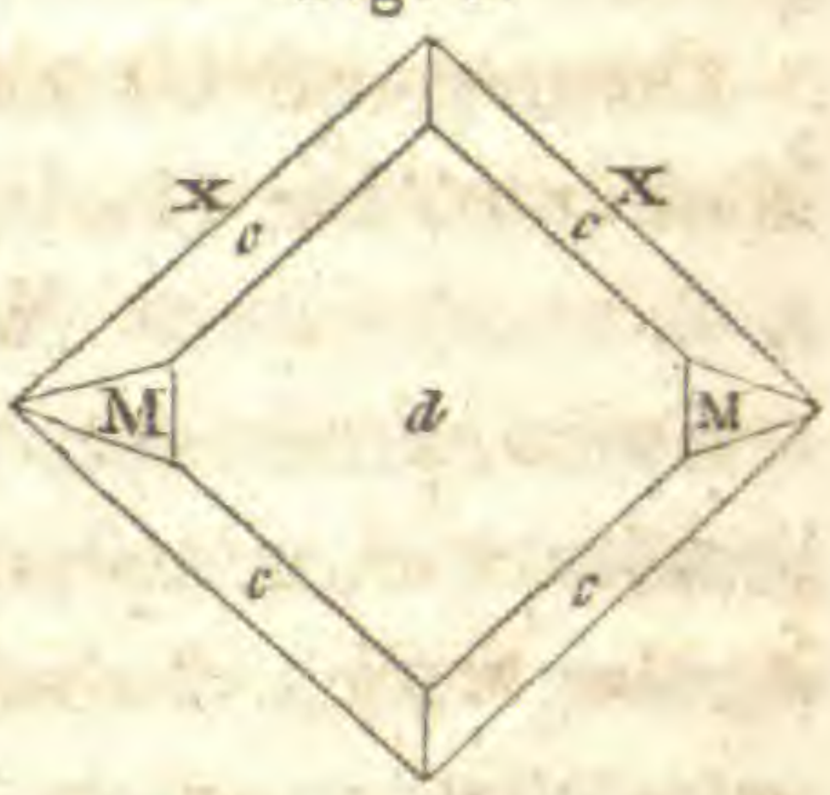
Rochester, N. Y., March, 1846.

Art. XXVII.—*On three new Mineral Species from Arkansas, and the Discovery of the Diamond in North Carolina;* by Charles Upham Shepard, M. D., Prof. of Chemistry in the Medical College of South Carolina, and in Amherst College, Massachusetts.

For the minerals here described from Arkansas, I am indebted to my friend, the Rev. E. R. Beadle, formerly missionary to Palestine, but at present, a resident in New Orleans. I believe them to have been collected by himself, during a late journey through the region of the Hot Springs.

1. *Arkansite.**

Fig. 1.



Primary form. Right rhombic prism. M on M, 101°.

Secondary form. M on *c*, 133° 45′.
c on *c* over the edge x } 135 15 †
edge x inclines to edge x at about 94°.

Cleavage indistinct. Surface, M brilliant, *c* less so, *d* brilliant, though drusy, and channelled vertically. Fracture sub-conchoidal, to uneven. Lustre metallic. Color dark steel-gray to iron-black. Faces *c* tarnished blue, like specular iron. Streak dark ash-gray. The powder (until it becomes perfectly fine) shows points with a metallic lustre.

Brittle. Hardness = 7·0—7·5.

When heated in a glass tube, the mineral affords no traces of moisture, or of hydro-fluoric acid. Alone, before the blowpipe, on charcoal, it is unalterable. With borax, it enters slowly into fusion, and gives a transparent, deep yellow glass.‡

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* Named from the State in which it is found.

† None of these angles were obtained from perfect reflections.

‡ A crystal weighing 0·68 gr. in the state of powder, was boiled for an hour in sulphuric acid, during which it underwent decomposition. The yellowish green insoluble matter separated, was thrown upon the filter and subsequently ignited. Its color became pale straw-yellow. Its weight was 0·32 gr. It afforded the reactions of titanic acid. The sulphuric solution (having been found to afford a precipitate with sulphate of potassa, which was soluble by addition of more of the saturated solution of sulphate of potassa) was precipitated, ignited and weighed. It amounted to 0·28 gr., and had the properties of yttria, though it is possible there might have been some intermixture of zirconia and thorina.

In a second trial, 1·68 grs. were fused with 12 grs. bisulphate potassa. The resulting mass had a faint tinge of yellow. It was boiled in excess of water, from which a fine, white, heavy powder was precipitated. Mingled with this powder was another, rather heavy, flocculent, grayish white matter, in small quantity, which remained behind in the basin as the other was removed to the filter by a stream from the wash-bottle. Sulphuric acid was boiled upon it without producing any change; but it afterwards slowly disappeared on being digested with hydrochloric acid. From a portion of this solution, ammonia threw down a precipitate, resembling yttria. The titanic acid, separated from the original sulphuric solution, weighed after ignition, 1·14 gr., or 67 p. c.

So far as my examination went, (which was restricted for want of material to examine, and the circumstance that my means for such inquiries were at the time, in Amherst,) I am led to regard the substance in question as a *titanate of yttria*, in which neither lime, oxide of cerium, iron or manganese are present.

The crystals are about one-fifth of an inch in diameter; and are implanted upon quartz crystals, which last are attached to a surface of a brownish green coccolite. The quartz crystals are dark brown within, but coated by a thin layer of milky quartz; and are about one inch in length, by one-fifth of an inch in diameter.

The ticket to the specimen is marked thus: "Magnet Cove. T 35. R 17 W. S 21. Hot Springs Co., Arkansas."

2. *Ozarkite.**

Massive. Composition, laminæ (confused) nearly impalpable. Fracture uneven.

Lustre feeble, vitreous to resinous. Color white (rarely bluish) to flesh-red. Streak white. Translucent.

Brittle. Hardness 4·5. Specific gravity, 2·746.

Heated in a glass tube before the blowpipe, it emits water very freely. (Ignited in the state of powder, it loses 15·1 p. c., and the powder is left slightly cohering.) Alone before the blowpipe, it melts almost with the facility of cryolite, into a transparent colorless glass. With borax, it dissolves into a transparent glass.

It dissolves freely without effervescence, in nitric and in hydrochloric acid, with deposition of silicic acid; and appears to be a siliceous hydrate of lime and yttria, possibly also having traces of thorina.

It occurs diffused in irregular veins and ovoidal masses (about one-fourth of an inch diameter) through a flesh-colored elæolite, from which mineral however, it is constantly separated by a thin layer of a red jasper-like substance, which is obviously distinct from the two minerals it tends to separate; and may itself be an undescribed species. Its locality, like that of the Arkansite, is Magnet Cove, Hot Springs Co., Arkansas.

3. *Schorlomite.*†

Primary form. Rhomboid. Dimensions unknown.

The species standing in the nearest relation to it, would seem to be the Æschynite, which however is a titaniate of zirconia and cerium; but the properties of the two minerals when contrasted, will at once show the impossibility of their being included within the same species.

* Named from the Ozark Mountains, in which extensive range its locality is situated.

† From *Schorl*, a familiar variety of tourmaline, and ὁμός, *like*, from its resemblance in color, fracture and crystallization to that mineral.

Secondary form. Hexagonal prism, with lateral edges truncated by narrow and brilliant planes.

Cleavage indistinct. Fracture conchoidal. Surface of the broader planes rather dull, of the narrow ones smooth and brilliant.

Lustre vitreous. Color black. Streak grayish black, with a tinge of lavender-blue. Tarnished with blue and pavonine tints, thus causing it to resemble specular iron, (for which substance it had been mistaken.) It also strikingly resembles some varieties of bluish black, massive, or imperfectly crystallized, tourmaline.

Hardness=7·0—7·5. Specific gravity=3·862.

Heated in a glass tube, it emits a little moisture, and glows with redness, immediately as the tube on which the fragment rests, becomes red. Its powder loses 3 p. c. on being ignited. Alone on charcoal, it fuses readily (and with scarcely any perceptible effervescence,) into a shining obsidian-like globule, which is not affected by the magnet. With borax, it gives a transparent glass, slightly tinged green by iron.

It is easily decomposed by the acids,—gelatinous silica being separated. It consists essentially of silicic acid, yttria, thorina,(?) oxide of iron and water. I could not detect in it, either oxide of cerium or lantanum.

It approaches in some of its properties the species allanite and gadolinite; from both of which it is sufficiently distinct however to entitle it to a specific rank.

The specimen affording it, is the same with that last referred to, as embracing the ozarkite. The crystals are very minute; but a large mass of the mineral occurs in elæolite, more than two inches in diameter, and which appears to belong to a single individual, which (like the indicolite crystals of Goshen) has been much interpenetrated by the gangue, so as on the whole to have less perhaps than one-half of the outline of the crystal occupied by the pure mineral. Fragments of pure schorlomite an inch in diameter, however, may be detached from this skeleton-crystal.*

* The elæolite with which this and the foregoing species are found, and which had been called a compact red feldspar, is a remarkably well characterized variety; is perfectly fresh and unaltered, forming a grayish flesh-red, oily, translucent mineral. Its sp. gr.=2·60. H.=6·0. It is fusible into a colorless glass, and in a state of a powder, at once forms with warm nitric acid, a flesh-colored jelly.

The same rock contains (and particularly the ozarkite and schorlomite portions of it) a yellowish-brown, semi-transparent, resinous mineral, which unless it should prove to be xenotime, may constitute a new species. It is highly crystalline; but the crystals are too small and incomplete to permit their determination. In hardness, it does not exceed 6·0.

4. *Diamond in North Carolina.*

At the 6th annual meeting of the Association of American Geologists and Naturalists, held in April, 1845, in this city, I made known the existence of the true, diamond-bearing rock (the Itacolumite) at several places within the gold region of the United States; and predicted that we should soon have other discoveries of the diamond within the range of this formation, in addition to the well authenticated one then already made, in Hall Co., Georgia. This opinion was circulated to some extent, by means of the newspapers in North Carolina; and as one of the first fruits of the inquiry set on foot, I had the pleasure of receiving last spring while in Charleston, from my friend the Hon. Mr. Clingman, of Asheville, Buncombe Co., the diamond here figured and described.* It was found in the gold washings of Mr.

It may not be without interest to annex here also, notices of several other specimens forwarded by Mr. Beadle from the same region.

a. Gray granite (without quartz) with black mica in small scales, imparting to the rock the aspect of a sienite. It contains everywhere diffused through its mass, minute, hyacinth-red crystals, having the hardness of monazite. From Fourche Cove, Pulaski Co. T 1 N. R 12 W. S 34.

b. From same place, (T 1 N. R 12 W. S 33.) a coarse amygdaloidal basalt, containing thickly implanted crystals of grayish black pyroxene, above an inch in length, and much resembling those found at Aussig, in Bohemia.

c. From little Missouri, Pike Co., (T 8 S. R 25 W. S 30.) Granular and fibrous snowy gypsum.

d. From do., (T 8 S. R 25 W. S 27.) Coarse granular and crystallized celestine, in large masses.

e. From do., (T 8 S. R 25 W. S 30.) Grayish white, granular celestine. Also in confusedly aggregated crystals, with rough, drusy faces.

f. From do., (T 8 S. R 26 W. S 16.) Celestine in large masses, crystallized and granular.

g. From do., (T 8 S. R 25 W. S 27.) Heavy spar in grayish white, tabular crystals and laminated masses, diffused through a steatitic clay.

h. From do., (T 8 S. R 25 W. S 27.) A yellowish white steatite, analogous to that found in Cornwall, England.

i. From same region, (T 8 S. R 25 W. S 27.) A trachytic porphyry. It has the dry, harsh feel, and emits the peculiar odor (when moistened) of the European trachytes. It is said by Mr. Beadle to be as recent as the tertiary.

j. From Saline Co., (T 2 S. R 16 W. S 14.) Compact reddish dolomite (had been supposed to be spathic iron) in quartz.

k. From Spring, (T 3 S. R 18 W. S 17.) Hot Springs Co. Light greenish grey trap-porphyry. A trachytic rock, with large, flat and perfect crystals of feldspar, slightly reddish. They resemble the ryakolite of Bohemia.

l. From Magnet Cove. (T 3 S. R 17 W. S 19.) A ryakolite-porphyry with a dark green basis. The rock contains little specks of a rich, azure blue mineral, which I am unable at present to determine.

* It is the crystal to which allusion was made in the last number of this Journal, p. 119.

Twitty's mine in Rutherford Co.; which mine is situated in the Itacolumite region I had designated in the communication above referred to. Mr. Clingman thus refers to it in a letter dated Feb. 17th, 1846. "By the desire of Mr. Twitty, I have enclosed to Dr. Dickson, (with the request that he would present it for examination to you,) a small crystal which seemed to me to possess the adamantine lustre, and was hard enough to scratch every thing to which I applied it, it cutting limpid quartz easily. Should you find it to be a diamond, would you regard the picking up of a single one among the gravel from a gold-rocker, as affording a sufficient inducement for instituting a search for diamonds at that place?"

Although there could be no mistake about the hardness and lustre possessed by this crystal, *i. e.*, that they could only belong to the diamond, still there was something in its singularly elongated shape, which at first sight was calculated to remind one of an hexagonal prism with trihedral summits, such as occurs in calcite, or tourmaline: but then the faces were each diagonally divided by a slightly raised edge; and besides, they all equally had the peculiar sphericity so frequent in the diamond. The crystal however, which is bounded by twenty-four isosceles triangles, is plainly enough a common secondary of the cube, through the bevelment of its edges; and its unusual figure arises from the disproportionate extension of the twelve planes situated about its vertical axis. See the figure in the margin.

Fig. 2.

Its weight is 4·12 grains, and its specific gravity=3·334. It is transparent, possessing only a faintly pale yellowish tinge of color; and it is nearly without flaw.

It is to be hoped that the proprietors of gold washings throughout the district, will immediately set on foot a systematic search for this precious gem, which, in the ordinary operations of gold mining, might be overlooked to almost any extent. Henceforth there can scarcely remain a doubt, but that the diamond is to form a part of the available mineral wealth of the country.

New Haven, July 21, 1846.

SCIENTIFIC INTELLIGENCE.

I. Chemistry.

1. *On the Electrical Conductibility of certain bodies;* by Ed. Becquerel, (Comptes Rendus, March 1846.)—It has been shown that the coefficients representing the relative conductibility of different substances, do not answer for different degrees of temperature; thus at 32° Fahr., silver conducts about 57 times more readily than mercury, while at 212° Fahr. the comparative conductibility of these two metals is as 44 to 1; the same amount of heat creating a much greater relative resistance in the silver than in the mercury. From the author's experiments the following table has been constructed.

Conducting power compared with that of silver at 32° Fahr.			Conducting power at 212° Fahr. compared with that of silver at 212° Fahr.	
	At 32° Fahr.	at 212° Fahr.		
Pure silver, (annealed)	100·	71·316	Silver, -	- 100·
" copper, " -	91·517	64·919	Copper,	- 91·030
" gold, " -	64·960	48·489	Gold, -	- 67·992
Cadmium, - -	24·579	17·506	Zinc, -	- 24·673
Zinc, - - -	24·063	17·596	Cadmium,	- 24·547
Tin, - - -	14·014	8·657	Tin, -	- 12·139
Iron, - - -	12·350	8·387	Iron, -	- 11·760
Lead, - - -	8·277	5·761	Platinum,	- 9·378
Platinum, - - -	7·933	6·688	Lead, -	- 8·078
Mercury, - - -	1·739	1·5749	Mercury,	- 2·208

J. Lawrence Smith.

2. *Liberation of Electricity by the bursting of a Bladder;* (Chemist, April, 1846.)—Mr. J. Duprèy has shown that in the well known experiment of bursting a bladder stretched over the mouth of a vessel, by the air pump, electricity is always liberated, and that it is of a positive character. It is shown by passing a brass rod through the side of the receiver, into which it is cemented, the inner end terminating with a knob, the outer being connected with an electroscope. J. L. S.

3. *Appreciation of the Force of Magnets;* by M. de Haldat, (L'Institut, No. 647, May 27, 1846.)—M. de Haldat has contrived a means of ascertaining the force of magnets, based on the influence exerted at a distance from a needle. The apparatus is extremely simple; it consists of a rule two to three meters long and three to four decimeters in width, subdivided into centimeters, and divided into two equal parts by a longitudinal line. A delicate needle twelve to fifteen centimeters in length, is fixed on a pivot on the meridian line; and a point of copper is adapted to it, to indicate by its coincidence with the ex-

tremity of the horizontal needle, the magnetic normal. The rule is placed horizontally and in an east and west direction, perpendicular to the magnetic meridian. In using it the magnet is made to approach the needle parallel with the sides of the rule. The distance at which it acts on the needle indicates its sphere of activity, as compared with any other magnet that may be operated upon. Not only different needles may be thus compared, but the different poles of the same magnet; and as the force diminishes as the square of the distance, the different lifting forces of magnets of equal transverse sections may be deduced. M. de Haldat, with the same means, has experimented on the effects of interposing different media between the magnet and the needle; and he finds no appreciable difference, whatever substance he used, or however great its thickness. This was true of iron as well as other substances. He has ascertained the singular fact, (an exception to the usual law of the propagation of these subtle fluids,) that the union of two magnets of equal intensity, although producing an increase of lifting force, does not increase the sphere of activity. The sphere of activity therefore cannot be enlarged except by adding a magnet of greater intensity, and then will equal that of this stronger magnet alone. This fact is likewise confirmed by the *magnetic phantom*, in which the rays and characteristic curves are made more distinct and beautiful by the uniting of two magnets, but the extent of the figure, produced by the action, is no greater than with one.

4. *Calorific Power of the Light of the Moon;* (A letter from M. Melloni to M. Arago, and Chemist, May, 1846.)—M. Melloni has shown, beyond a doubt, that the rays of the moon are calorific to a slight extent. It was done by concentrating the rays of the moon with a lens over three feet in diameter, upon his thermoscopic pile. The needle was found to deviate from 0°·6 to 4°·8 according to the phase of the moon. Numerous precautions had to be attended to so as to avoid all error arising out of currents of air, &c. J. L. S.

5. *On the Cohesion of Liquids and its effect upon the phenomenon of Ebullition;* by F. Donny, (Annales de Chem. et de Phys., Feb. 1846, p. 167.)—These experiments disclose some very remarkable circumstances connected with the cohesion of the particles of liquids. They were undertaken upon the author's observing that a syphon gauge constructed by him with sulphuric acid, (perfectly free from air,) for the purpose of testing the airpump vacuum, was useless; the acid remaining stationary, being sustained by the adhesion of the acid to the tube and the cohesion between its own particles;—and by means of these forces alone, he succeeded in sustaining a column of sulphuric acid (free from air) four feet in height, even in a perfect vacuum, and notwithstanding the apparatus being repeatedly agitated.

With distilled water *free from air*, the same phenomenon was observed, and by a series of comparative experiments the author is led to believe that cohesion alone can sustain a column of water over 33 feet. It is the absence of air alone that allows the particles of liquids to approach each other more closely, and exercise more powerfully their cohesion, which, when air is present, interferes but slightly with the changes that liquids undergo, as for instance ebullition, that happens at about the temperature at which their vapors enter into equilibrium with the atmospheric pressure. But if water is as free from air as it is possible to make it, it can be *heated to the temperature* 275° *Fahr. without manifesting the slightest traces of ebullition, and that, even in a vacuum*;—this remarkable fact has been proved by experiment, the instrument used for it being a kind of water hammer,—so arranged that the vapor in the upper part could not be heated, and thereby exercise a pressure upon the water,—which was heated to 275° Fahr. without the adhesion of the particles giving way; showing that this force was superior to the pressure of three atmospheres, as under ordinary circumstances, water, heated to 275°, furnishes a vapor equal to that pressure.

But if the water heated to this high temperature be divided in any way, steam is disengaged instantly and with great violence, the temperature at the same time falling. In this way those sudden bursts of vapor, which are often so annoying during the evaporation of liquids, are explained. At the first part of the ebullition while air is present the vapor is uniformly produced, the temperature of water and vapor being the same; but the air once gone, the cohesion of the liquid interferes in the process; this induced the author to try what effect a current of air passing through the liquid would have in preventing these explosions, which resulted in perfect success.

M. Donny thinks that the cause of certain explosion of boilers, may be deduced from these facts, and proposes as a means of preventing them, to throw in at the bottom of the boiler a small stream of air.

These experiments have an important bearing upon the point of ebullition of liquids. It is impossible to enter more into detail concerning these interesting researches, which extend over more than twenty pages, but which recommend themselves to the perusal of chemists and natural philosophers. J. L. S.

6. *A New Method for the Quantitative Determination of Iron;* by M. Marguerite, (Comptes Rendus, April, 1846.)—This method is based upon the fact, that when a solution of the permanganate of potash—the chameleon mineral—is added to a solution of the protoxide of iron, the former is discolored so long as any of the latter metal remains in the state of protoxide. With this in view the author proceeds as follows. 1. Dissolve the ore in hydrochloric acid. 2. Convert the persalt of

iron into a protosalt by the addition of sulphite of soda, and boil the solution to expel the excess of sulphurous acid; it is important that none of this latter substance should be present when the next step in the operation is made, this can always be ensured by having an excess of hydrochloric acid. 3. Add, with precaution, from a graduated vessel a solution of the permanganate of potash, the strength of which is known, and by reading off the number of divisions consumed, before any pink tint appears in the solution of iron, the amount of this latter metal present is calculated; in this part of the process, it is necessary to have the solution very dilute.

The manner of preparing this test liquid is as follows.—The chameleon mineral is first prepared as proposed by Gregory; by fusing together chlorate of potash, hydrate of potash, and peroxide of manganese in the proportion of one atom of the first, three of the second, and three of the third. The fused mass is treated with water, so as to obtain a concentrated solution to which is afterwards added dilute nitric acid until it acquires a violet color;—the solution is now filtered and ready for use. To obtain it of the proper strength, dissolve one gramme of pure iron in hydrochloric acid, dilute with about one quart of water, and add from a graduated vessel the solution of chameleon mineral, until the pink color appears; noting the number of divisions of the solution consumed, we are then in possession of all the data necessary for future analysis.

None of the substances associated with the ores of iron interfere with the accuracy of the result, except copper and arsenic, both of which are got rid of by adding a piece of zinc to the solution of the ore in hydrochloric acid before it is treated with the sulphite of soda.

J. L. S.

7. *On the Quantitative Determination of Mercury;* by E. MILLON, (Annales de Chem. et de Phys., 1846, and Chem. Gaz., March, 1846.) —A long glass tube, such as is used in organic analysis, is first contracted near to one of its extremities, and at the very extremity drawn out to a point and curved upwards; the space between the two contractions being from three to four inches. A small quantity of asbestus is introduced into the tube next to the point first contracted, and upon this are placed fragments of caustic lime to the extent of six or eight inches; the mercurial compound is next introduced varying from 15 to 60 grains, and then the tube is filled with caustic lime similar to the other. In the analysis of nitrate of mercury, the lime should be replaced by metallic copper. The tube is now placed in the furnace used for organic analysis. A current of pure hydrogen (purified by passing the dry gas over copper turnings heated to redness) is made to enter at the uncontracted extremity, and the heat applied exactly as in organic anal-

ysis. The water is first seen on the portion of the tube between the contractions; it is dissipated by gently heating it; this part of the tube is then allowed to cool, and the mercury soon makes its appearance, condensing in its turn without any difficulty. At the end of the operation, the part of the tube containing the mercury is separated by slightly moistening the heated tube; the portion of the tube is weighed with the mercury it contains, the mercury poured out, the particles adhering to it removed by nitric acid; it is then washed, dried, and weighed again. The difference of the two weights gives the weight of the mercury. J. L. S.

8. *A New Method of estimating Copper;* by M. PELOUZE, (Comptes Rendus, Feb., 1846.)—It is based upon the discoloring of a solution of a persalt of copper in ammonia by any deoxydizing agent. The following is the method of procedure. One gramme of pure copper is dissolved in half an ounce of nitric acid, the solution diluted with a little water, and slight excess of ammonia added. A solution of sulphuret of sodium in water is next made, (Pelouze used about 4 oz. to a quart of water—this however is altogether arbitrary,) poured into a graduated tube, and let fall drop by drop upon the solution of copper, heated to boiling, until the discoloration is complete. The quantity of sulphuret used is noted, and it then becomes a standard solution, of which so many divisions of the graduated tube are required to discolor one gramme of copper.

If we now wish to analyze an alloy of copper, it is dissolved in nitric or nitro-muriatic acid, super-saturated with ammonia, heated to boiling, and discolored by the solution of sulphuret; the required quantity of which is noted, and from our knowledge of the amount required for one gramme of copper, we estimate the quantity of this metal present.

By this method M. Pelouze says that we can approximate to within one-half per cent., and even less if great care be observed. The presence of tin, zinc, lead, arsenic and antimony, do not interfere with the accuracy of the result; nickel and cobalt will. The solution of sulphuret slowly undergoes alteration by contact with the atmosphere, so that it is necessary prior to each assay, to test the strength of the sulphuret by a known weight of copper. J. L. S.

9. *A new test for Manganese;* by R. PHILLIPS, (Chemist, April, 1846.)—Place the solution of manganese in a bottle, so that it may cover the bottom of the phial to the depth of about the tenth of an inch, and lay on the fluid a common stick of phosphorus, by which means one half of the stick will be exposed to the air; the mouth of the bottle should be but imperfectly closed. After keeping the bottle in the dark for a few hours, the fluid will be found to possess a beauti-

ful amethystine tint, if it contains any manganese; by exposure to the light of the sun the fluid soon becomes colorless, but the color may be again renewed by placing the bottle in the dark. J. L. S.

10. *Separation of Cobalt from Manganese;* (Journ. de Pharm, March, 1846.)—M. Barreswil has taken advantage of the fact that sulphuretted hydrogen will precipitate cobalt from a perfectly neutral solution of all its salts, but not the manganese. The object to be arrived at, is to keep the solution neutral as the cobalt is precipitated, which is done as follows:—An excess of carbonate of baryta is added to the solution containing the cobalt and manganese, and through it the sulphuretted hydrogen is passed. The cobalt is precipitated, the manganese remains in solution, and the carbonate of baryta keeps the solution neutral without interfering with the result. The rest of the analysis is conducted in the ordinary way. J. L. S.

11. *Upon the Precipitation of different Organic and Mineral Substances by Animal Charcoal;* by M. Weppens, (Rev. Scientifique, Feb., 1846, p. 251.)—The animal charcoal used was prepared from bones, and washed repeatedly with boiling hydrochloric acid in order to dissolve the phosphate of lime. Thus prepared it precipitates bitter extracts, resins, and astringent substances from solution. 5 parts of colocynth, gentian, columbo, and quassia being infused in 600 parts of water, this latter was completely deprived of its bitter taste by 16, 10, 5, and 16 parts of charcoal respectively for the four substances mentioned. 600 parts of water containing $1\frac{1}{2}$ of aloes was rendered tasteless by 21 parts of charcoal. The sulphates of copper, zinc, chrome, iron, the nitrates of mercury, nickel, cobalt, silver and other metallic salts are to a certain extent precipitated by animal charcoal. J. L .S.

12. *On the Incandescence of Iron, Copper, Brass, &c., in the Vapor of Alcohol;* by Prof. Böttger, (Annalen der Pharm. und Chem., Jan., 1846.)—Dr. Riensch has lately discovered that the above metals heated to a certain point, would, under favorable circumstances, glow in the vapor of alcohol. Prof. Böttger endeavors to show that this phenommenon is not attributable to the metals themselves, but rather to their oxides, for he says every one who has performed the experiment as described by the author, must have found that it requires a long time for it to succeed perfectly, and when it is successful it will be found that it is owing to the surface of the iron having become oxydized. He farther states, that a coil of wire, which from repeated use has been superficially converted into oxide, will glow in the vapor of alcohol quite as well as pure metallic platinum. J. L. S.

13. *A New and Simple Method of preparing Chloric Acid;* by Prof. Böttger, (Annalen der Chem., Jan., 1846, and Chem. Gaz., March, 1846.)—A solution of chlorate of soda is first prepared by decompo-

sing bitartrate of soda with chlorate of potash, in the following manner:—seven parts by weight of crystallized carbonate of soda, and $7\frac{1}{2}$ parts by weight of tartaric acid, are dissolved in twenty-four parts of boiling water, and to this boiling solution is added six parts by weight of chlorate of potash previously dissolved in sixteen parts of water likewise heated to 212° F., at the same time agitating the mixture. As soon as this is done, it is taken from the fire and allowed to cool, in order that the bitartrate of potash formed may separate properly; after which it is poured on a double paper filter, and to the filtered liquid is added a saturated solution of oxalic acid, consisting of six parts by weight of oxalic acid, and eighteen parts of water heated to about 134° F.; the whole is then well agitated, and the vessel placed in an ordinary refrigerating mixture, for the better separation of the oxalate of soda, which is then entirely and easily removed by a simple filtration. This method is based upon the superior solubility of the chlorate of soda over the same salt of potash, and upon the sparing solubility of the oxalate of soda. The chloric acid thus obtained is, it is true, not absolutely pure, but still sufficiently so for most chemical and technical purposes—for instance, for the preparation of chlorate of barytes, which is so much consumed in the manufacture of fire works. To obtain a chemically pure and at the same time more concentrated acid, the solution above obtained should be treated with recently precipitated carbonate of baryta, avoiding any rise of temperature; but the solution of the barytic salt may now be evaporated over the fire, and the large beautiful crystals which soon form are pulverized, dissolved in water, and decomposed with a corresponding quantity of sulphuric acid. J. L. S.

14. *A ready Method of preparing Hypochlorous Acid;* by M. Williamson, (Journ. de Chem. Med., March, 1846.)—Saturate a neutral solution of sulphate of soda, at the ordinary temperature, with chlorine. A large amount of chlorine will be absorbed, and the liquid will contain bisulphate of soda, chloride of sodium, and hypochlorous acid. If the liquid be distilled, the hypochlorous acid will come over with the first portions of water. This acid will be found very useful in the laboratory, as it possesses an oxydizing agency superior to nitric acid at the ordinary temperature. J. L. S.

15. *Preparation of Chromic Acid;* by M. Bolly, (Annal. der Chem. und Pharm., vol. lvi, p. 113.)—This is a modification of Fritzsche's method, and is based upon the fact that concentrated sulphuric acid precipitates chromic acid from solution if a little water be present. Take a weighed portion of bichromate of potash and make a boiling saturated solution; during ebullition, add sufficient concentrated sulphuric acid to form bisulphate with the potash of the chromate. Decant the

liquid portion from the granular mass, add repeatedly small portions of water to the granular mass and decant, until the residue of bisulphate is of an orange color. Unite the portions decanted, concentrate by evaporation, precipitate the chromic acid by sulphuric acid, throw it upon a funnel and let it drip, spread it on porous bricks, redissolve and crystalize. In this way large crystals of the pure acid can be obtained. The solution of chromic acid in sulphuric acid is a powerful oxydizing agent.
J. L. S.

16. *Preparation of the Phosphuret of Nitrogen;* (Rap. Annuel de Berz., 1845, p. 40.)—M. Balmain has pointed out the following method which furnishes very readily the substance in question. Heat gently in a flask, chloramide of mercury, and then add phosphorus in small pieces so long as any reaction takes place. Agitate from time to time, and complete the operation by heating the bottom of the flask to redness. The sal-ammoniac, excess of phosphorus, and mercury, is volatilized, and the phosphuret of nitrogen remains behind. J. L. S.

17. *Economical Method for preparing the Protoxide of Copper;* by M. Wittstein, (Revue Scient., Feb., 1846, p. 258.)—Dissolve 1 part of sulphate of copper and 1 part of sugar of milk in 10 parts of water, and add to the cold solution a solution of caustic potash until the precipitated hydrated oxide of copper is redissolved by agitating the liquid. The blue solution is heated in a water bath, it being kept constantly agitated. In a very short time the color passes to a grayish green, and a precipitate begins to appear, which is at first brown, but becomes finally of a cinnabar red color. So soon as this happens, withdraw the vessel from the fire, and place it in cold water to facilitate its cooling; after which it is readily collected on a filter. If the action of heat be continued its color becomes changed. J. L. S.

18. *Amount of Carbon expired by Man;* by E. A. Scharling, (Annal. der Chem. und Pharm., vol. lvii, p. 1.)—These researches have reference to the amount of this substance expired by the skin as well as by the lungs.

	Carbon from the lungs in one hour.	Carbon from the skin in one hour.
	Grains.	Grains.
Adult of 28 years, . .	174·7	5·74
Young man of 16 years, .	166·4	2·78
Boy of 10 years, . . .	98·9	1·90
Young girl of 19 years, . .	123·7	4·20
" " " 10 years, . .	95·7	1·90

J. L. S.

19. *Mode of dividing plates of Zinc;* by M. Waidele, (Revue Scient., Feb., 1846, p. 257.)—It is frequently a subject of great annoyance to divide plates of cast zinc used in galvanic batteries. The follow-

ing is a simple and ready method of accomplishing this end. Grease the plate over by means of a rag and a little tallow,—with a pointed instrument draw a line in the required direction of the cut, so as to remove the grease from that spot, and penetrate slightly into the metal,—pass a little dilute sulphuric acid over this line by means of a feather, and then let a drop or two of mercury fall on the same spot,—the zinc soon becomes amalgamated in the direction of the line, and through its entire thickness; a slight blow properly given will cause it to break.

J. L. S.

20. *On the Presence of Carbonates in the Blood;* by R. F. MARCHAND, (Journ. für Prakt. Chem., April, 1846, and Chem. Gaz., June, 1846, p. 213.)—In these experiments the author endeavors to substantiate his former opinion upon this subject, which is in opposition to that of many chemists. One of the methods by which he proceeded to establish the presence of carbonates in the blood was as follows:—

The mass obtained by evaporating five pounds of blood in a retort, was conveyed into a long-necked flask, closed with a cork, through which a long funnel and a tube for conducting away the gas were inserted; the latter was fitted air tight into a Woulf's bottle, which was half filled with a clear solution of barytes. On heating the liquid in the flask to gentle ebullition, the steam passed through the barytic solution, causing not the slightest turbidness during the course of half an hour; but on pouring dilute sulphuric acid through the funnel, and continuing the gentle boiling, a white precipitate very soon appeared which subsided in dense flakes, and after separation from the clear liquid, dissolved entirely in a little hydrochloric acid, so that the precipitation could not have arisen from any sulphuric acid having been carried over. The author repeated this experiment three times and always with the same result; so he thinks himself justified in his conclusions concerning the presence of carbonates in the blood. J. L. S.

21. *On the presence of Sulphocyanogen in Human Saliva;* by MAX. PETTENKOFER, (Buch. Rep. xli, p. 289, and Chem. Gaz., May, 1846, p. 191.)—As authors are not agreed upon the occurrence of Sulphocyanogen in the saliva, Gmelin, Ure, Liebig and Wright, speaking in favor of it, whilst Berzelius, Kühn and Müller are opposed to it, it appeared requisite to the author to investigate the subject again. The saliva used was collected from the author himself, and its secretion was promoted by smoking tobacco.

The saliva in its examination was evaporated almost to dryness, exhausted with strong spirits, again evaporated and the residue dissolved in water. The solution was very strongly reddened by neutral chloride of iron and let fall some brown flakes, but it could not be caused to disappear by the addition of chloride of sodium or ammonium. The extract was boiled with sulphuric acid, and a moist piece of lead paper held over it, which latter was rendered brown by sulphuretted hydrogen. It was submitted to other characteristic tests for sulphocyanogen and responded to all of them.

The mode of formation of the sulphocyanogen in saliva has hitherto proved a stumbling-block; but if we regard urea as a cyanate of ammonia, C^2NO+NH^4O, and compare the formula of sulphocyanide of ammonium with it, $C^2NS^2+NH^3$, we find a striking relation between them; for if we place 2 equiv. of oxygen in the urea by 2 equiv. of sulphur, we have the elements of sulphocyanide of ammonia. Moreover, the products of decomposition of the two substances on destructive distillation are to a certain extent similar. The author has also found that urea may be converted into a compound of sulphocyanogen by the action of alkaline sulphurets. Since the urea occurs already formed in the blood, it would not appear improbable that by combining in the salivary glands with the sulphur in the protein compounds, it forms sulphocyanogen. Wright has remarked the excretion of urea in the saliva during salivation. J. L. S.

22. *On the Digestion of Amylaceous and Saccharine Substances;* by M. Mialhe, (Comptes Rendus, March, 1846.)—The author has found that the saliva contains a principle identical with vegetable diastase. It is procured by treating the filtered saliva with 5 or 6 times its weight of absolute alcohol, which precipitates the substance in question in the form of white flakes, which can be collected on a filter and dried. It is readily preserved if kept in well stopped bottles. It does not act upon fibrine, albumen, gluten, or any of the azotized substances;—if heated with starch and water in a sand bath, to a temperature of from 158° to 175° Fahr., the starch is rendered soluble, it being converted into dextrine and glucose.

The saliva contains about $\frac{1}{500}$th of this principle, which the author seems to think exerts remarkable effects in the digestion of amylaceous substances;—as regards their assimilation, as well as that of saccharine substances, he is still of opinion that the alkalies of the blood exert considerable influence. J. L. S.

23. *On the Nourishing Quality of different Vegetable Substances, reckoned from the amount of Nitrogen contained in them;* by E. N. Horsford, of Albany, U. S., (Annal. der Chem. und Pharm., vol. lviii, p. 166.)—This is a very able research conducted in the laboratory of Prof. Liebig by the author, who appears to have devoted much time and care to the analyses. Besides simply estimating the amount of carbon, hydrogen, nitrogen, oxygen, sulphur, and ashes in the various vegetable substances that passed through his hands, the proportion of vegetable azotized substances contained in each one is also laid down; this is calculated from

the amount of nitrogen and the known composition of these principles as made out by Mülder, Scheerer and others.

The following is the statement of the nutritive value of some of the substances alluded to in the extensive table accompanying the memoir. Wheat is taken as the standard, and the numbers in the table represent how many parts of the corresponding vegetable are equal to 100 of wheat.

	Theory.		Experiments on animals by Boussingault.
	Dried at 212° F.	Fresh.	Fresh.
Wheat, ...	100·	100·	94·
Rye, ...	98·8	97·6	97·6
Corn, ...	115·	113·	108·
Rice, ...	220·	225·	
Buckwheat, . . .	170·	166·	122·7
Pease, ...	57·	60·	90·7
Lentil, ...	55·	58·	
Potato, ...	220·	596·3	429·
Yellow Beet, . . .	182·7	919·4	589.7

J. L. S.

24. *A Description of a new Mercurial Trough;* by Prof. Louyet, (Phil. Mag., May, 1846.)—It consists of a small oblong oak-box, $1\frac{3}{4}$ inches in depth, nine inches in length, and six inches in breadth. To the bottom is cemented a plate of glass exactly covering its whole extent; this glass has a small piece cut out of the middle of one of its shorter sides, either of a rectangular or V shape, extending about an inch and a half from the margin; the upper surface of the glass is ground perfectly level. The side of the box next to which comes the edge with the piece taken out, has a groove cut in it from the top to the bottom, terminating in an excavation in the bottom of the box; just over which the rectangular opening in the glass comes; so that a bent tube coming from a vessel in which gas is being generated, may have its lower extremity placed beneath the floor of the trough. The receivers used are tubulated, having the lower edges well ground. To fill the receivers, the lower edge is placed upon the bottom of the trough, it being previously greased if thought necessary, the stopper withdrawn, and then it is entirely filled with mercury and restopped. A small quantity of mercury is next poured into the box, so as to fill the small cavity, and cover the bottom for about the tenth of an inch; the receiver can now be moved in all directions, and placed over the cavity into which the extremity of the curved tube from which the gas is disengaged, is placed. The advantage of this species of trough is that with a small amount of mercury, large receivers may be used.

J. L. S.

II. Arts.

1. *Artificial Marble*, (Journ. de Chem. Med., April, 1846, p. 299.)—M. Bouisson has taken out a patent for preparing artificial marble from gypsum, which is to be cut of the required size, placed in a metallic trough in a furnace, and kept at the temperature of 90° for some time, after which a solution of alum in boiling water is poured upon it and a gentle heat continued for some length of time, the water being renewed as it evaporates. For a block six feet long and two feet in the other directions, exposure for five hours before the addition of alum solution, and seventy-two hours after, suffice to impregnate the plaster. The strength of the alum solution is one pound to six quarts of water. It is always well to cut the plaster in the form required before hardening it. By introducing coloring matter into the solution, various tints may be obtained. J. L. S.

2. *Preparation of a Substitute for Horn ;* by M. Rochon, (Voigt. Mag. de Naturk. and Revue Scient., Feb., 1846, p. 256.)—In many of the arts, more especially where steel instruments are manufactured, glass windows are of great inconvenience owing to the frequent breakage by fragments of steel. The substitution of horn is attended with some inconvenience, principally on account of its want of transparency. A substitute is proposed to be made of very light cloth or wire gauze composed of fine brass wire, which is to be immersed repeatedly into a solution of isinglass until all the meshes are filled and a sufficient thickness acquired, after which it is covered with a coat of copal or other varnish to protect it from the weather. J. L. S.

3. *Amalgamation of Wrought Iron, Cast Iron and Steel, so as to prepare them for Fire Gilding*; by R. Boettger, (Poggend. Ann., 1846, No. 1, and Bib. Univer., March, 1846, p. 201.)—Place in a glazed earthen ware or porcelain vessel 12 parts by weight of mercury, 1 of zinc, 2 of sulphate of iron, 12 of water, and $1\frac{1}{2}$ of hydrochloric acid of 1·2 sp. grav. ; then introduce the iron or steel into the mixture, which is to be heated to ebullition. In a little time the objects become covered with a thin coating of mercury ; which enables us to apply immediately, the amalgam of gold that is used in the gilding. All that is now necessary, is to apply a strong heat which will drive off the mercury and the trace of zinc that may have attached itself to the iron, leaving a surface of pure gold. By the ordinary way, it becomes necessary to cover the iron first with a coat of copper. J. L. S.

III. Mineralogy and Geology.

1. *Oriental Jade and Tremolite*, by M. Damour, (Ann. de Ch. et de Phys. April, 1846; Phil. Mag. xxiii, 568.)—The jade selected for analysis had been worked in India; it was of a milk-white color and semi-transparent, and had the appearance of white wax, or perhaps rather spermaceti. Its fracture was splintery; it scratched glass, but feebly. Its specific gravity was found to be 2·970. Its tenacity was very great; when reduced to powder and heated in a glass tube, its appearance was not altered, and it yielded no water. In the flame of the blowpipe it swells up, and fuses slowly into a milk-white enamel. Borax dissolves it without color; the salt of phosphorus dissolves it, leaving a skeleton of silica. It is not sensibly acted upon by hydrochloric acid.

Two analyses gave the following results:—

Silica,	58·46	58·02
Lime,	12·06	11·82
Magnesia,	27·09	27·19
Protoxide of iron,	1·15	1·12
	98·76	98·15

M. Damour having observed that this is precisely the composition of tremolite (white hornblende), submitted this substance to the same process of analysis as that adopted with the jade. The specimen which he selected was from St. Gothard, and in colorless crystals, very perfect and associated with granular dolomite, which was separated by hydrochloric acid previously to analysis.

It yielded—silica 58·07, lime 12·99, magnesia 24·46, protoxide of iron 1·82,=97·34.

From the similarity of these results, M. Damour is of opinion that this jade may be ranked with tremolite; and if this opinion should be adopted, he observes, that in collections oriental jade will hereafter be classed as *compact tremolite*.

2. *Substances in Guano;* by E. F. Teschemacher, (Phil. Mag. xxviii, 546, June, 1846.)—Mr. Teschemacher has detected the following substances in guano:—

Phosphate of Ammonia, occurring as a crystalline salt, perfectly transparent, with a brilliant cleavage in one direction. The quantity was too small for an analysis.

Bicarbonate of Ammonia, mixed with guano in its cavities as a crystalline salt, having brilliant cleavage in two directions. Measurement with the reflecting goniometer gave the angle of 112° between the adjacent planes. It proved on analysis to consist of ammonia 21·0, carbonic acid 55·50, water 23·50, =100, affording nearly the formula NH_3+2CO_2+2HO.

Ammonio-magnesian phosphate, imbedded in patches in the guano of Saldanha Bay on the coast of Africa. It occurs in distinct brilliant crystals, highly modified, having for its primary a right rhombic prism of 57° 30′ and 122° 30′, with rhombic cleavage. The specific gravity is 1·60 and hardness 2. It afforded on analysis, ammonia 14·30, magnesia 17·00, phosphoric acid 30·40, water 38·10, =99·80, giving nearly the formula NH_3MgO, PO_5+5HO. It is usually white and translucent, though sometimes discolored brown. Mr. Teschemacher proposes the name *guanite* for this species, it being the first occurrence of the compound as a native salt.

Besides these, there were detected in the guano of Saldanha Bay small globular particles consisting of concentric laminæ, which gave on analysis, carbonate of lime 37·50, carbonate of magnesia 32·00, phosphate of lime 12·00, water with a little ammonia and animal matter 12·00, sand 3·00, alkaline sulphates and chlorides 52·50, =99·50.

3. *Struvite*, (L'Institut, No. 644.)—Like the Guanite, this mineral, described by M. Ulex, is a phosphate of ammonia and magnesia; but it differs in containing 13 per cent. of water. The primary is a rhombic prism of 95° 10′; sp. gr. 1·7; hardness that of talc; slightly soluble in water. It was found on the site of an old church at Hamburg.

4. *Cryptolite;* by F. Wöhler, (Pogg. Ann., No. 3, 1846; Phil. Mag., xxix, 31, July, 1846.)—Cryptolite is a phosphate of the oxyd of cerium, found in the sea-green or reddish apatite of Arendal in Norway. It becomes apparent when the apatite is placed in large pieces in dilute nitric acid, appearing, as the apatite dissolves, in the form of fine crystalline needles of about a line in length. It occurred only in the reddish variety of apatite and constituted but 2 or 3 per cent. of the mass. It crystallizes in transparent apparently six-sided prisms of a very pale wine color; specific gravity 4·6. It undergoes no change at a moderate heat. It afforded on analysis peroxyd of cerium 73·70, protoxyd of iron 1·51, phosphoric acid 27·37, =102·58. The excess arises from the cerium having been determined as peroxyd instead of protoxyd, in which latter form it evidently exists in the mineral. The presence or absence of didymium and lanthanum remains undetermined.

It is probable that the apatite of Arendal contains another cerium mineral which is soluble, and it may possibly be monazite.

5. *On the Hematite in Connecticut;* by J. G. Percival, (Report on the Geology of Connecticut, p. 132.)—The rock which contains the Hematite iron ores in the northwest part of Connecticut and the adjoining part of New York, is a micaceous schist, the predominant variety of which has a light grey color, is sometimes more or less talcose, and often contains garnets and staurotides. Greenish (from chlorite) and

bluish varieties also occur, the latter highly pyritiferous and approaching argillite. The Hematite region includes within its limits the ore beds of Salisbury, Sharon and Dover; and traces may be observed more or less frequently throughout the formation from Patterson to Massachusetts. Mr. Percival goes on to observe:—"From the observations I have made, I have been led to believe, that the Hematite, like bog ore, is of secondary formation, and is derived from the decomposition of the pyrites, contained in the mica slate of the formation, particularly in the black sub-argillitic variety, and in a less degree, in the dark blue variety with transverse mica. Seams of Hematite may not unfrequently be observed in these varieties of the mica slate, which are besides characterized by their dark red brown rusted surface. The ore beds themselves present usually a distinctly stratified arrangement, in parallel beds interposed between the strata of the undecomposed mica slate adjoining, and quartz veins are also found in the ore beds, arranged precisely as they occur in the unaltered rock of this formation. The ore is accompanied with alternate layers of a yellow or reddish ochry earth, called fuller's earth by the miners, derived apparently from the decomposition of the light grey mica slate of the formation, which corresponds, in this respect, with the light grey mica slate of the preceding formation, as already observed. The different results, from the decomposition of the different varieties of mica slate, may perhaps depend on the peculiar composition of each, or on the fact, that magnetic pyrites abounds more particularly in the darker varieties, and common pyrites in the latter. The most important ore beds in Salisbury, namely, the Ore Hill, and Chatfield's, are situated on the east side of the depression south of Taconic Mountain; the others, in that town, along the east base of that mountain, farther north. Indian Pond ore bed, (Sharon,) is at the western base of the ridge next south of Taconic Mountain, towards its southern termination, and the Dover bed, on the eastern declivity of the present formation, west of Dover.

"This formation extends only a short distance along the west line of the state, namely, from west of Sharon village, to its northwest corner, being chiefly included within the limits of New York and Massachusetts."

6. *Subsidence of the Land at Puzzuoli*, (Jameson's Edinb. Jour., xl, 1846, 385.)—Mr. J. Smith stated to the British Association, that when he visited the temple of Jupiter Serapis at Puzzuoli, in March, 1819, its floor was elevated about 6 inches above the level of the sea; but on the 11th of May, in the year 1845, it was covered to the depth of 18 inches at low water, and 28½ at high tide,—the sea being calm at the time. The *custode* of the building told Mr. Smith that this change was progressive, amounting to 1¼ English inches per annum.

The cicerone, too, who had exercised his profession for thirty years, said, he knew a difference of at least 3 feet 6 inches in the height of the sea upon the piers of the Bridge of Caligula, giving the same amount of subsidence yearly. There were, besides, many similar proofs in the partly submerged houses and causeways of Puzzuoli. The perforations of the Pholades in the columns indicate a former period, during which the temple remained submerged at a stationary level; and contemporary accounts state, that, by an instantaneous movement, it was lifted to some height above the sea, which receded nearly 200 paces, leaving an immense quantity of fish, which were collected by the inhabitants. This took place in October, 1538, immediately before the elevation of Monte Nuovo.

7. *Notice of an Earthquake and a probable Subsidence of the Land in the district of Cutch, near the mouth of the Koree, or Eastern branch of the Indus, in June*, 1845. (Extracted from a letter to Capt. Nelson, R. E.—Journ. Geol. Soc. 1845, p. 103.)—" One of Capt. McMurdo's guides was traveling on foot to him from Bhooj. The day he reached Luckput there were shocks of an earthquake, which shook down part of the walls of the fort, and some lives were lost. At the same time as the shock, the sea rolled up the Koree (the eastern) mouth of the Indus, overflowing the country as far westward as the Goongra river (a distance of twenty English miles), northward as far as a little north of Veyre (forty miles from the mouth of the Koree), and eastward to the Sindree Lake. The guide was detained six days (from June 19th to 25th), during which time sixty-six shocks were counted. He then got across to Kotree, of which only a few small buildings on a bit of rising ground remain. Most of the habitations throughout the district must have been swept away, the best houses in Scinde being built of sun-dried bricks, and whole villages consisting only of huts made of a few crooked poles and reed mats. The guide travelled twenty miles through water on a camel, the water up to the beast's body. Of Lak nothing was above water but a Fakeer's pole (the flagstaff always erected by the tomb of some holy man); and of Veyre and other villages only the remains of a few houses were to be seen.

" There are said to be generally two earthquakes every year at Luckput. The Sindree Lake has of late years become a salt marsh."

8. *On the Vorticose Movement assumed to accompany Earthquakes;* by R. Mallet, (Phil. Mag. xxviii, 537, June, 1846.)—The phenomenon to which Mr. Mallet refers, is the apparent displacement and twisting of the stones of a column of masonry, as if produced by a partial revolution around a vertical axis. He shows that the supposition of an actual vorticose movement in the earth is not only improbable, but unnecessary to account for the facts: and farther that a simple horizontal

motion is sufficient, if the centre of adherence, in the stone to be moved, is not directly under the centre of gravity. This is proved by simple trial. With regard to the possibility of restoring of the stone to its original position by the backward move of an earthquake vibration, he argues that the forward and backward action are not equal, as the force producing the earthquake is usually progressive in one direction; and further, the new condition of the stone, after the first motion, renders it scarcely possible that the reverse motion, however, nearly the same, could exactly neutralize and return the stone to its former place.

The following are some instances of this peculiar motion mentioned as on record.

"The first notice I find recorded of such a peculiar motion, is in the Philosophical Transactions, in an account of the earthquake at Boston, in New England, of November 18th, 1755, communicated by John Hyde, Esq., F. R. S. He says, 'the trembling continued about two minutes; near one hundred chimneys were levelled with the roofs of the houses, and many more shattered. Some chimneys, though not thrown down, were dislocated or broken several feet from the top, and partly turned round as on a swivel. Some are shoved to one side horizontally, jutting over, and just nodding to fall,' &c. This author does not seem to have been struck with this odd circumstance of the twisting round of the chimneys, and offers no explanation. The next instance that I have found is in the account of the great earthquake of Calabria, in 1783, as recorded by the Royal Academy of Naples, quoted by Mr. Lyell, in his Principles of Geology, vol. i, page 482. After describing several other remarkable phenomena, tending to show the great velocity of the shock, such as that many large stones were found, as it were, shot out of their beds in the mortar of buildings, so as to leave a complete cast of themselves in the undisturbed mortar; while in other instances the mortar was ground to powder by the transit of the stone, he says, 'Two obelisks (of which he has given figures) placed at the extremities of a magnificent façade in the convent of St. Bruno, in a small town called Stephano del Bosco, were observed to have undergone a movement of a singular kind. The shock, which agitated the building, is described as having been horizontal and vorticose. The pedestal of each obelisk remained in its original place, but the separate stones above were turned partially round, and removed sometimes nine inches from their position without falling.'

"I have found some few other notices of similar phenomena in old books of travels. Two additional instances, however, will be sufficient. The first will be found in the quarterly journal of the Royal Institution, in a narrative of the earthquake in Chili, of November, 1822, communicated by F. Place, Esq.

"The church of La Morceda, at Valparaiso, built of burnt bricks, stood with its length north and south. [The houses are built of adobes, or sun-dried bricks.] 'The church tower, sixty feet high, was leveled; the two side walls, full of rents, were left standing, supporting part of the shattered roof, but the two end-walls were entirely demolished. On each side of the church were four massive buttresses, six feet square, of good brickwork; those on the western side were thrown down and broken to pieces, as were two on the eastern side. The other two were twisted off from the wall in a northeasterly direction, and left standing.' The direction of the shocks was thought to be either from the southwest, or from the northwest.

"The last instance I shall quote is from the pages of the able and delightful Darwin, in his Journal of a Naturalist's Voyage, (Colonial Library, edit. p. 308), in describing the effects of the great earthquake of March, 1835, upon the buildings in the town of Conception; and after noticing also the evidences of immense velocity in the shock, by which the projecting buttresses from the nave walls of the cathedral had been cut clean off close to the wall, by their own inertia, while the wall, which was in the line of shock, remained standing; he proceeds, —'Some square ornaments on the coping of these same walls were moved by the earthquake into a diagonal position. A similar circumstance was observed after an earthquake at Valparaiso, Calabria and other places, including some of the ancient Greek temples' (for which he quotes Arago, in *L'Institut*, 1829, p. 337, and Miers's Chile, vol. i, p. 392)."

9. *Geological Chart of M. Boué*, (Bull. de la Soc. Geol. de France, 2 Ser., i, 572.)—The fine large geological chart by Boué embraces a general view of the geology of the globe, and was published under the auspices of the Geological Society of France. The following results appear to be established by it:

1. The more ancient formations prevail towards the poles, in the principal ossature near the equator, and around the great ocean.

2. The intermediary (Silurian) formations exist about the poles and in the northern temperate zone. But they fail almost entirely under the equator.

3. The secondary formations rest in the concavities of the intermediary formations in the northern hemisphere, whilst they rest upon the primary of the equator.

4. The tertiary abound near the equator; they fill the lowest points of the basins of the sea, and form a zone extending from the Desert of Cobi, the country about the Caspian Sea, to the low plain in the north of Europe; whilst another similar zone extends from the northern part of the basin of the Euphrates, passes by Arabia and continues even to the Andes, and thence to the foot of the Himalaya towards the Ganges.

10. *Analysis af the Glassy Scoria of Kilauea, Hawaii*, (Proceed. Bost. Soc. Nat. Hist., July, 1846, p. 121.)—This glassy scoria including some of the capillary glass of the volcano, has been analyzed by Mr. J. Peabody in the laboratory of Dr. C. T. Jackson, with the following result: silica 50·00, protoxide of iron 28·72, lime 7·40, alumina 6·16, potash 6·00, soda 2·00, =100·28.

IV. Zoology.

1. *Description of two New Species of Fossil Echinodermata, from the Eocene of the United States*; by Samuel George Morton, M. D., (Proceed. Acad. Nat. Sci. Philad. iii, 51, May, 1846.)—*Cidaris Alabamensis.* Compressed, pentagonal, the angles rounded so as to form a ten sided figure. Ten rows of tubercles, with nine or ten in each row. Ambulacra arranged in five pairs, with delicate, slightly oblique fissures separated by a double elevated line. Surface between the tubercles and ambulacra finely granulated.

Galerites? Agassii. Elevated, hemispherical, with four pairs of ambulacra which diverge from the apex and meet at the margin, having each two rows of pores connected by transverse fissures. Surface marked by numerous, distinct granulations, which are continued over the whole base of the fossil.

I have much pleasure in dedicating this remarkable species to M. Louis Agassiz, whose profound researches into this class of organized beings, have thrown much new light on their structure, affinities and geological relations.

Both these fossils were found by Dr. Albert Koch, in the Eocene strata of Washington Co., Alabama, and by him politely submitted to me for description.

2. *Description of a New Species of Bat from Western Africa—Pteropus Haldemani;* by Edward Halowell, D. M., (Proceed. Acad. Nat. Sci. Philad., vol. iii, No. 3, p. 52, May, 1846.)—General expression ferocious; head resembling that of a dog; ears of moderate size, smooth for the most part, obtuse at the tip, hairy at base externally; there is no tragus; body dark brown above; neck, occiput and vertex same color, but lighter than upon the back; wings and interfemoral membrane of a sienna brown color above and below; thorax and upper part of abdomen and sides brown; the rest of the abdomen is white; there are two long and thin hairs upon the muzzle; lips full, nostrils prominent, their margins being surrounded by a fold of the skin; eyes rather large, irides ——; wings long; that portion of the membrane included between the phalanges naked, the remainder more or less hairy above and below: upper surface of the interfemoral membrane hairy, with the exception of a small part at its posterior extremity which is

naked; under surface also hairy, but much less so than upper; no tail; tibia and fibula included within the membranes; four slender toes, compressed, of nearly equal length, the outer one being a little shorter than the others; they are sparsely furnished with thin hairs, varying in length; the terminal phalanx of each is provided with a robust, sharp and incurvated nail. The index finger like the thumb is also furnished with a short and incurvated nail.

Measurements.	Inches.
Total length,	$3\frac{1}{2}$
Length of head,	$1\frac{3}{4}$
Distance between anterior margin of nostril and anterior canthus of eye,	$\frac{5}{8}\frac{1}{10}$
Distance between angle of mouth and anterior canthus of eye,	$\frac{3}{8}$
Length of neck, body and tail,	3
Length of forearm,	3
Length of tibia,	$1\frac{1}{4}$
Spread,	$14\frac{1}{4}$
Length of thumb,	$\frac{3}{4}$

Dental Formula.

Incisors.	Canines.	False Molars.	Molars.
$\frac{2—2}{2—2}$	$\frac{1—1}{1—1}$	$\frac{1—1}{2—2}$	$\frac{2—2}{3—3}$

This species I have named after my esteemed friend, S. S. Haldeman, Esq., author of the N. American Limniades, who obtained it with other African animals from Dr. Goheen, Physician to the American Colonization Socieiy.

3. *Description of Unio abacoides, a new species*; by S. S. Haldeman, (Proceed. Acad. Nat. Sci., Philad., iii, 75, June, 1846.)—Shell subovate, obtusely and regularly rounded posteriorly, disks approximate, chesnut brown and pale green, with green radiating interrupted capillary lines, and a tendency to form a submedial nodulous ridge: primary teeth robust, their inner margin nearly at right angles with the short lamellar teeth: pallial and muscular impressions well marked: nacre white, roseate posteriorly.

Length $2\frac{5}{8}$, height 2, diameter $1\frac{1}{8}$ inches.

Allied to U. dromas, *Lea*, and U. intermedius, *Conrad*, but is proportionally longer than either. In its outline and small transverse diameter it resembles U. abacus. I am indebted for this interesting shell to the liberality of Dr. Foreman, who received it from Eastern Tennessee.

4. *A New Species of Apus.—A. longicaudatus;* by John LeConte, F. L. S., (Ann. Lyc. Nat. Hist. N. Y., iv, 156.)—Pale brown: *buckler*

large, thin, gibbous, nearly round, carinate on the middle of the back, deeply emarginate behind, the edges of the emargination fringed with short spines: *eyes* three, simple, the two anterior larger, approximate, somewhat lunate, the third one round, placed in the middle behind the two others: *antennæ* very short, inserted near the mandibles, two-jointed, joints cylindrical, subequal, the second joints somewhat accuminate and naked at the tip: first pair of *feet*, or as they have been called, exterior antennæ, furnished with four articulated filaments; of these filaments, the outer one is longer than the body, the next half the length of the first, the third about one-third the length of the second, and the fourth very short: the other feet, amounting to ten pair, are flattened, trifid at the tip, the intermediate division being the longest, furnished on the inner side with a short branch, and externally with a broad lamina; below these feet are twelve pair of laminæ, the five anterior pair larger, the seven smaller pair reaching to the vent, which is covered by the last pair; these laminæ are complicated in their structure, and ciliate with short hairs: *tail* long, consisting of sixteen joints counting downwards from the vent, the last one the longest, somewhat coriaceous, emarginate and ending in two long articulated naked filaments; the joints of the tail and of the filaments are furnished each with a row of small spines, which run entirely round.

Length to the end of the tail, 1·5 of an inch—of the buckler, ·65—breadth of the same, 7.

Of the habits of this animal, we know but little; it was found in immense numbers in a small shallow lake on the high plateau between Lodge-pole creek and Crow creek, northeast of Long's peak, in the Rocky Mountains: they were swimming about with great activity, plunging to the bottom and rising to the surface. All of them that were caught appear to be males, at least none of them have any ova attached: the common species in Europe, A. cancriformis, on the contrary, has never been found but of the opposite sex.

5. *The Soft Bodies of Polythalamia found in a Fossil State.*—In a microscopical examination of chalk and flint by Dr. Mantell, published last August in the Annals of Natural History, it was announced for the first time, that the soft parts of foraminifera occur in a silicified state in the flints of the southeast of England. Dr. Mantell has followed up his researches, and has succeeded in obtaining the internal soft parts of rotaliæ, in the state of a dark brown carbonaceous substance, retaining the perfect form of the interior of the shell in which, when the animal was living, they were enclosed. This discovery was made by immersing chalk in weak hydrochloric acid, by which process not only the lime, but the calcareous shells the earth contained, were dissolved; the residuum being only grains of white and green transparent quartz, and

animal matter. This detritus was prepared for microscopical investigation by the usual process with Canada balsam; and several examples of the remains of the integumentary structure of rotalia were found, as perfect as insects in amber; even the *ova* remained in some examples; and in all, the connecting intestinal tube, with the little stomachs or sacs, the latter containing a brown granular substance, were preserved. Dr. Mantell has sent a communication on the subject to the Royal Society.

6. *Boring power of Land Snails on Limestone;* by W. C. TREVELYAN, (Jameson's Edinb. Jour., xl, 1846, 396.)—Few persons are, I believe, aware of the fact, which I alluded to at the meeting of the British Association in Cambridge last year, on the occasion of a notice by Dr. Buckland, "On the agency of land snails in forming holes and trackways in compact limestone," that this phenomenon had been noticed many years ago by the late amiable and talented author of the History of Northumberland, the Rev. John Hodgson, an accurate observer of nature, who, in 1827, published in that work (part 2, vol. i, p. 193) the following passage:—"On a sunny bank near Whelpington, a stratum of limestone" (carboniferous) "is here and there seen in gray projecting masses, the *under* surface of which is bored upwards into cylindrical holes, which are from a line to four inches deep, and tenanted, especially in winter, by the banded and yellow varieties of the *Helix nemoralis.* The *limax*, while it occupies these cavities during summer, has its fleshy longitudinal disk protruded out of the shell, and coiled nearly into a circle on the surface of the stone, the summit of its shell hanging downwards; and in this position it probably elaborates its den in the same manner that some of the *pholades* work their way into clay and wood, or, by a slow but constant process, sink and enlarge their cells in the hardest stones." I had, sometime previously to the date of this publication, examined the spot, and was satisfied with the correctness of Mr. Hodgson's observations, and last October (1845) took advantage of an opportunity to revisit it, and was confirmed in the opinion I had before formed on the subject, and in the perfect accuracy of the description quoted above.

The thoroughly sheltered position of the *under* surface of the rock precludes the possibility of the holes being an effect of weathering; and I feel convinced that they are the result of the slow, but nearly constant action, of a weak acid secreted by the snails, which instinctively, for the sake of shelter, would resort to such a situation, and thus, in the course of ages, such holes would be formed in any substances on which the acid could act.

7. *On the Cause of the Circulation of the Blood;* by Dr. J. W. DRAPER, (Phil. Mag., March, 1846.)—In the memoir before us, the au-

thor gives a definite idea of how the capillaries and tissues operate in producing the circulation; that they are powerfully instrumental in this important function is now generally admitted; the circulation being considered due to a "series of vital attractions and repulsions not essentially different from those which are witnessed in physics and chemistry;" but we have never yet been informed what these attractions and repulsions are due to. It is on this point that Dr. Draper has thrown much light.

The physical principle upon which this new theory is based, is explained in the following manner.—If, in a vessel containing water, a tube of small diameter be placed, the water immediately rises to a certain point in the tube, and remains suspended. Let the tube be now broken off below that point, and replaced in the cup of water; the liquid rises as before, but though it reaches the broken extremity, it does not overflow. A capillary tube may raise water to its highest termination, but a continuous current cannot take place through it. If, however, the liquid at the top of the tube be allowed to evaporate, it will be replaced by that from the vessel, causing in this way a current through the tube; the same is true if the liquid be ignited, as in the case of an ordinary lamp, the wick of which draws the oil to the top, where it remains stationary until ignited, when it flows upwards through the wick until the lamp is emptied.

It is seen from these facts that ordinary capillary attraction can under certain circumstances determine the continuous flow of a liquid through a tube. But there is yet another circumstance under which this might happen, as where the attraction between the liquid and sides of the tube is greater at the point where they first come in contact, than farther up the tube.

Suppose a capillary tube composed of some substance having a strong attraction for oxygen, to be immersed in an oxydizing liquid, the liquid will enter the tube under strong attraction, but losing its oxygen the attraction diminishes as it passes into the tube, and if the attraction between the first portion of the tube and the liquid remains the same, this last will continue to enter and push forward that part that has lost its attraction for the sides of the tube. The above fact is expressed by the author in the following terms.—If a given liquid occupies a capillary tube, or a porous or parenchymatous structure, and has for that tube or structure at different points affinities which are constantly diminishing, movement will ensue in a direction from the point of greater to the point of less affinity.

This principle is applied to the *systemic circulation* in the following way. The arterial blood charged with oxygen, penetrates the various tissues by means of the capillaries, and as there is a strong attraction between the tissues and oxygen, this last becomes absorbed, (producing the destruction of the tissues); this happening in the first part of the capillary system, and the blood behind being charged with the same gas, and the same attraction existing, the first portion after losing its oxygen and consequently its attraction for the sides of the vessel, is pushed onward by the arterial blood from behind responding to the attraction of the tissues, when it in turn loses its oxygen, and is pushed forward by another portion, thereby causing a continuous flow from the arterial to the venous system.

With the *pulmonary circulation* the reverse takes place—the venous blood passes onwards, pushing forward the arterial. Here the air cells of the lungs, along which the capillary system of the pulmonary vessel passes, contain oxygen, between which and the venous blood there is considerable attraction, but none between it and the arterial; so when the venous blood becomes charged with oxygen, it loses its attraction for the walls of the capillaries, and is pushed onward by venous blood not yet acted upon.

The *portal circulation* is explained in a similar way. Between the portal blood and the structure of the liver there is an energetic affinity, betrayed by the circumstance that a chemical decomposition takes place, and bile is separated; and that change completed, the residue, which is no longer acted upon, forms the venous blood of the hepatic veins, and is driven onwards by the affinities taking place between the portal blood and the substance of the liver. Another power which aids in forcing the blood from the portal into the hepatic veins, is the passage of the blood from the hepatic arteries into the portal veins, which is brought about by the cause alluded to in speaking of the systemic circulation.

The author also alludes to the *fœtal circulation* in the placenta, which is similar to the pulmonary circulation,—deoxydized passing onward toward oxydized blood. The umbilical arteries carry in their spiral courses, as they twist round the umbilical vein, the effete blood of the fœtus, and distribute it by their ramifications to the placenta. In that organ it is brought into relation with the arterial blood of the mother, which oxydizes it, becoming by that act deoxydized itself. The fœtal blood now returns along the ramifications of the umbilical vein, and finally is discharged from the placenta by a single trunk.

The application of the principle here set forth, furnishes a very felicitous explanation of a great number of effects which we witness. It is well known that after ordinary death, whilst the arteries are empty, the systemic veins and also the right cavities of the heart are full of venous blood. The reason is clear, although the ordinary theory, that the heart acts like a pumping machine, fails as is well known to explain it. As long as arterial blood is deoxydizing, it will move to the venous side, a movement which must continue until the arteries are empty.

In the same way, in fainting, the blood leaving the arteries, accumulates on the venous side, and as its flow is dependent on the push of the arterial blood entering the capillaries, so soon as no more enters, no pressure is exerted in the venous trunks, and if a vein be opened there is no discharge, and under such circumstances hemorrhages at once cease.

Dr. Draper in the same memoir offers some new views concerning the coagulation of blood, which are highly important, but as yet are not fully established. J. L. S.

V. Botany.

1. *Sigillaria and Stigmaria.*—Several new examples of the occurrence of Stigmariæ as the roots of the trees termed Sigillariæ, have been brought before the Geological Society of London. Mr. Binney describes an upright trunk of a Sigillaria with Stigmaria roots fifteen feet long, spreading out into the surrounding clay; the top of the trunk terminated in the coal above the bed of clay. It was found in the coal at Dunkinfield, in about the same geological position as the one described in Dr. Mantell's Medals of Creation, at St. Helen's; from which locality it is about twenty-five miles distant. In the Sydney coal-field, at Cape Breton, Mr. Brown describes several, and states that upright trees with roots (Stigmariæ) may be seen in the cliffs near Sydney harbor. It is to be hoped that a specimen will be dug out with the roots and stems in conjunction, and placed in some public museum, so as to satisfy the most sceptical; for many eminent geologists still doubt the accuracy of the above inferences.

2. *The relations of Noggerathia with living Plants.*—The memoir on this subject, read by Ad. Brongniart before the French Institute on the 29th of December, is inserted in the *Ann. Sci. Nat.* for January last. The plants referred to this genus appear to have contributed largely to the formation of coal. As the result of a very acute investigation, M. Brongniart removes this genus from the Palms, and confidently refers it to the Cycadaceæ. The memoir closes with the following interesting remark. "This genus being excluded from the class of Monocotyledons, the *Flabellaria borassifolia* of Sternberg being also removed from the family of Palms to the Gymnospermous division, and the genus Artisia being in the same case, there only remain in certain ancient formations, such vague indications of the presence of the great Monocotyledonous division of the vegetable kingdom, as are furnished by several fruits, the structure of which is too imperfectly known to warrant their being referred with any probability to

that natural division, so long as no known stems or leaves can be referred there. Thus, the conclusion to which all researches up to the present time seem to lead is, that the terrestrial vegetation of the coal-epoch was limited to two great divisions of the vegetable kingdom, viz. the Acrogenous or Vascular Cryptogams, and the Gymnospermous Dicotyledons. A. Gr.

3. *Structure of the Trunk of Cycas circinalis*, (Ann. Sci. Nat., Jan. 1846.)—From the examination of some old trunks of Cycas received from Java, Prof. Miguel draws the following conclusions.—1. The stem of Cycas is composed of two sorts of elementary organs, viz. *parenchymatous cells* and *dotted vessels*, agreeing in this respect with the structure of Coniferæ. 2. In the distribution of these elementary organs, it differs greatly from that of Coniferæ : the wood is disposed in irregular concentric layers, confluent at certain points, unequal, having no relation with the buds, separated by broad layers of cellular parenchyma. 3. In the development of the tissues there are several peculiarities which are not found in Coniferæ ; for instance, in the increase of the trunk in length from the summit only, in the preponderance of parenchymatous cells, in the ligneous parts being traversed by cortical parenchyma, &c. 4. In this acrogenous growth and by the clefts in the woody layers, there is a distant resemblance with the trunk of Ferns ; but the continuous peripheric growth is a complete distinction. 5. The structure of the trunk of Cycas, in all its peculiarities, more nearly resembles certain vegetables of a former epoch, than of the present. The author then compares the trunk of Cycas with that of Zamia and Eucephalastos, which have a single woody cylinder, with or without medullary rays.

A. Gr.

VI. Astronomy.

1. *Fifth Comet of* 1846.—The comet discovered May 19, 1846, by Mr. George P. Bond, of Cambridge, Mass., and the elements of which were published at p. 138, had been previously detected (on the 2d of that month) by the sharp-sighted astronomers of the observatory at Rome. Mr. B. was, however, the *discoverer*, so far as America is concerned, both of this comet and also of that whose elements are given at p. 447 of vol. i, 2d Ser. ; and is entitled to none the less credit, because anticipated by one of the large corps of European observers.

2. *Antares, a triple star.*—Prof. Mitchel of the Cincinnati observatory, found in June, 1845, that Antares is accompanied by a minute star distant only 1·7″. In a communication dated July 30, 1846, in the *Union*, Lieut. M. F. Maury, of the Washington observatory, announces the discovery just made there, that this star has a second companion, and is of course a *triple* star. The principal star is *red ;* the companion discovered at Cincinnati is *blue ;* the second companion is *green.*

3. *Supposed New Planet*, (L'Institut, No. 648, June, 1846.)—At a session of the French Academy of Sciences, June 1, 1846, M. Leverrier read a memoir in which he states that after a full discussion of the subject, he is satisfied that it is impossible to represent the motions of the planet Uranus, except by supposing the existence of another planet beyond Uranus, and at twice its mean distance. The heliocentric longitude of this new planet, January 1, 1847, he gives at 325°, a place which he thinks will not be in error ten degrees.

VII. Miscellaneous Intelligence.

1. *The Potato Disease.*—As the season approaches when the ravages of this disease generally make their appearance, it is desirable to know how far investigations already entered into, have proceeded towards the detection of the cause of such an evil, and the suggestion of a remedy. Little has as yet been done on any organized plan in this country. In Europe the case has been very different. In Holland and Belgium a committee was first appointed to collect facts calculated to throw light on the nature of the disease. In one of the Dutch provinces, Groningen, a separate commission was appointed for the same purpose.

In Germany, Liebig among others has turned his attention to the potato, and has lately published some observations on its nitrogenous constituents.

A number of the French philosophers, both alone, and under the auspices of the Central Society of Agriculture, have also attended to the subject. M. Payen has lately published three or four reports containing the results of elaborate microscopic and chemical researches.

The English government sent a commission to Ireland, of three distinguished scientific men, with directions to obtain as much information as possible on the nature and extent of the disease. In Scotland originated the most extended scheme of all. The subject was taken up in its several branches as it is connected with botany, meteorology, entomology, and chemistry. Each branch was referred to a competent person, and the investigation is still in progress.

It is not as yet even certainly determined in what form the disease first attacks the plant. A great number of observers have considered that it is first seen in patches of dark colored fungi on the leaves, thence gradually spreading down to the tubers. Dr. Ferguson in Paris, and several others in England, think that they have detected the sporules of the fungus passing down through the stem in the ordinary circulation of sap. But there are well authenticated instances where the potato tops have remained green and flourishing while the tubers were much diseased ; it cannot therefore be said with certainty that the disease first appears as a fungus on the leaves.

All agree that the nitrogenous compounds in the tuber are affected first, and to a peculiar state of these constituents, Liebig and others have referred the origin of the disease. The starch is attacked last, and often remains uninjured when the walls of the cellular tissue that enclose its globules are nearly destroyed. From potatoes which have become even offensive in their smell, perfectly good starch has been extracted. The manufacture of starch becomes of great importance in the economical disposition of the diseased potato.

The report of the Groningen commission ascribes the disease to the wetness and sudden changes of the two last years. M. Payen thinks that excessive moisture has predisposed the potato to yield to the attacks of fungi. Mr. Phillips of London has published a pamphlet in which he ascribes the whole thing to the same cause. These are only a few of those who advocate this view of the question. All who have experienced much rain, assign this as the cause of disease, not knowing that it has been quite as bad on dry soils and where there has been little rain. In all the west of Scotland the summer of 1845 was considered rather a dry one, and in Islay, one of the Western Islands on the Scotch coast, the streams had not been so low for many years. The potatoes were as much affected in this part of Scotland as on the east coast. These facts seem quite decisive on the subject of wetness, for one well authenticated case where the disease has occurred under circumstances that preclude the idea of its being caused by wet, renders the theory quite untenable.

It is not so easy to decide whether atmospheric influence is the cause of the disease. In order to arrive at any certain conclusion on this point, extended meteorological observations are necessary. It is a singular fact that three or four counties forming the extreme northern point of Scotland were entirely free from it; without any essential difference in their season from that of the other counties, so far as was known by ordinary observers. The overseer of Mr. Fleming of Barochan, in Renfrewshire, Scotland, lifted from one of his fields on the 5th of September last (1845) about 5 cwt. of potatoes; these were stored in the house and remained perfectly sound at the date of his writing, in the middle of winter. From the same field on the 15th of September were lifted 5 cwt. more of the same potatoes. These after being in the house two days, were tainted and decaying, as was the case before the end of September with all that were left in the field. In this instance the crisis in the change from the healthy to the diseased tuber took place between the 5th and 15th of September. If the disease had shown itself at this time simultaneously in every part of that district, this fact would go far to show that it was caused by some atmospheric influence; but the contrary was the case. In some fields it appeared as early as

July, even on adjoining farms. The cause then remains still a mystery.

Of remedies a very great number have been suggested; many without due consideration.

The commissioners sent by the English government into Ireland were particularly unfortunate in this respect, for want of a little practical knowledge added to their undoubted scientific attainments. All the means of prevention that have formerly proved successful failed during the last year. An excellent method has been to change the seed every year, taking it from a high country to the lowlands, but this was found to have lost its efficacy. Gypsum, and hot slaked lime, have also been of little benefit. The *greening* of potatoes intended for seed, by letting them lay in the sun, has been much recommended, and on cutting up the sun burned potatoes it has been found, according to some statements, that the greened parts were never diseased. It may be well to turn attention to this subject. In former years some persons succeeded in invigorating the crop by means of certain saline manures, and even during the last season it was thought that they were in some degree beneficial. We are not aware that any plan heretofore suggested has proved uniformly successful over any great breadth of country.

The preservation of the crop during the winter has excited the deepest interest, and here also the number of methods proposed defies enumeration. The result of all the trials seems to be that the disease makes very slow progress and in many instances none at all, when the potatoes are kept *perfectly dry* and *well ventilated.* Both of these conditions seem absolutely essential; packing them in dry absorbent earth, and even in charcoal has proved a signal failure. It is necessary in any case where the disease has made much progress to pick over the heaps frequently, and carefully select all of the affected tubers. Kiln drying has been resorted to in cases of extremity; this preserves the potato for food but of course destroys its vitality.

Of the various plans proposed for the planting of potatoes in spring, none has been found more efficacious than cutting carefully selected potatoes into sets, containing each two or three healthy eyes. These setts are sprinkled with sulphuric or hydrochloric acid, diluted in the proportion of one pound of acid to four gallons of water. Newly slaked lime, or gypsum is then added so as to form a crust over the cut surface.

The diseased potatoes have not been found injurious as food. In Scotland all kinds of domestic animals have been fed with them freely, and actually thrived upon them. We have in the present communication glanced merely at the principal points of interest hitherto touched, in the researches upon this subject; it is much to know which are false theories, even if we have made little positive advance.

Prof. Johnston in a late communication has informed us that from attentive consideration of the analyses of diseased and healthy potatoes made in his laboratory during the past year, he has been led to recommend the application of a certain manure to the potato crop, as calculated, in many cases if not universally, to arrest the disease. He does not speak of this with confidence, but as a thing yet to be tried. The publication containing his paper has not yet reached us and we are consequently unable to say more.

We are forced to conclude that the origin and causes of this disease are at present unknown; its mysterious marks have appeared suddenly on two continents, separated by wide oceans; under heat and drought, rain and cold, on wet and dry, light and heavy soils, at every elevation, and in every variety of potato. Those who have most carefully investigated its peculiarities, most widely examined its range, are most undecided as to its cause.

Only by a very long and extended series of experiments, by an accumulation of accurate results, can we hope to arrive at a solution of this mysterious problem. No subject of the present day offers more attractions to the scientific man, or a wider field of usefulness. The very existence of a crop of incalculable importance seems at stake; practice has entirely failed in its efforts to correct the evil, and looks to science for that aid, which, if within the limits of possibility, should be afforded. J. P. N.

2. *Paper from the banana.*—M. Rogue has proposed in a late communication, the manufacture of paper from the fibres of the banana, and trials by a committee succeeded in producing a white and good paper. M. Rogue intends to carry on this operation in Algeria, not merely from the banana, but also from the aloes and other textile plants; and it is said that a large grant of land has been made to him in the Colony for that purpose.

3. *On the Mounds and Relics of the Ancient Nations of America.*—(The following is an extract of a letter from the senior editor to Dr. G. A. Mantell, London.)—At a special meeting of the Connecticut Academy of Arts and Sciences, July 7, 1846, various interesting facts relating to the mounds of the Ohio and Scioto valley, and specimens from them, illustrating their objects and the habits of their builders, were laid before the Academy, by Mr. E. Geo. Squier. These structures of the west are either enclosures, some evidently intended as fortifications, or mounds of various forms and sizes. This gentleman, in connection with Dr. Davis, of Chillicothe, Ohio, has opened eighty of the mounds, and has attended personally at the excavation of more than sixty. The developments are wonderful, and our explorer has satisfied himself that of the mounds, 1st. Many are sepulchral; 2d. Others sacrificial; 3d. Others for lookouts and alarm posts.

In the sepulchral, are found human bones, generally much decayed, so that no skeletons and rarely a perfect bone can be extricated—so ancient are they; and often the mounds of all descriptions are covered by gigantic forest trees. In one instance a section of a tree gave 600 annual rings. The sacrificial mounds cover altars sometimes of large size and constructed of baked earth hardened like bricks or tiles, and more rarely of stone. These altars contain calcined human bones, charcoal, and other proofs of the operation of fire. The merely sepulchral piles are earth mounds thrown up at random without arrangement of the materials; those covering altars were artificially stratified—layer over layer of alternating beds of gravel, earth and sand, but following a common curvature, like a series of caps drawn over the same head; this stratification, when heretofore named but not fully and accurately reported, induced Prof. Hitchcock to suppose that the mounds were diluvial; but their form and the interred altars with their relics disprove that opinion, although we know not why the altars were covered with so much care, or why covered at all: probably the proceeding was interwoven with their religious notions. In both kinds of mounds, but more especially in the mounds of sacrifice, are found very remarkable works of art wrought in stone. Among them were images of many of the animals and birds of that period; they were often wrought into pipes of various fanciful shapes; an otter with a fish in its mouth; a hawk tearing a bird to pieces; owls, eagles, bears, &c., and many human heads and faces, giving doubtless the craniology and physiognomy of the people—besides many things not exactly obvious as to their import. There are many stone arrow and spearheads beautifully chipped out of hornstone of various colors, or formed from obsidian, or limpid quartz; and among the relics are much white mica in flakes, vessels of pottery, and pipestone similar to that of Prairie du Chien described in the American Journal, Vol. xxxviii, p. 140. The minerals grouped in these mounds came often from remote regions, and thus furnish proof of extensive migrations, or friendly or warlike travelling or commerce. There are strings of beads of ivory, (probably from the mastodon or *Elephas primigenius*, which were cotemporary in this country,) strings also of pearls—doubtless from the fresh water molluscs, and possibly from the Gulf of Mexico; and there were also fossil teeth of sharks, and other teeth probably cetacean. Besides, there are chisels and axes of native copper, and articles of silver. [The copper doubtless came from Lake Superior, where it is now found abundantly, and at this moment thousands are exploring there for it on both the American and British side of the lake. The great mass weighing from three to four thousand pounds, (see Amer. Jour., iii, 204,) now lies in the court-yard of the War

Office at Washington, and a piece weighing 1630 pounds is almost in view from the window at which I am writing, in the door-yard of my friend Mr. Forrest Shepard, an active geological explorer; both these grand pieces with native silver adhering to them, are from the Lake Superior Copper Region.]

The telegraphic mounds (No. 3) extended in ranges at convenient distances for many leagues; so that fires kindled upon them would give early and effectual notice of the approach of an enemy, as I remember to have seen in England, in August, 1805, when Napoleon's invasion was expected.

The enclosures serving as regular works for defense, were furnished with parapets, ditches, towers at the angles, and covered ways especially to supplies of water near rivers. These works appear, often, to have included a dense population in villages; and it is obvious that the hundreds of earth structures found in the valley of the Scioto, and the thousands, many thousands, in Ohio and other states, (not a few of which I have seen in Ohio, Illinois and Missouri,) necessarily implied a considerable population: and of course it was agricultural, at least in part, as they could not in such numbers subsist upon the chase alone; and there must have been an energetic government to coerce, or powerful mental influence to induce, so much labor. The present Indians do not submit to such toils, and have only very humble arts. They have however often buried their dead in the ancient mounds; but it is easy to distinguish these more modern deposits.

The ancient mounds were always erected in plains and valleys of fertile land, and on alluvial river deposits; and in some cases there are river terraces at lower elevations than those on which the mounds are found, thus perhaps indicating their high antiquity.

These explorations by Messrs. Squier and Davis differ from all preceding ones, not only by their number, but by the thorough manner in which the researches are made, an entire section of the mound having been cut from top to bottom, thus disclosing its contents. They have at Chillicothe, six thousand specimens which have been taken from the mounds, a selection of which will be made, to illustrate a work on this branch of archæology which is now in the course of preparation.

Mr. Squier has presented his subject in some of the principal northern cities of the U. S., where it has excited much interest; and both a learned individual and a learned society have volunteered the sums requisite for its publication. The races that constructed these works were probably the precursors of the Mexicans and Peruvians, and may have either deserted their structures to move farther south, or been driven from them by war.

The mounds resembling animals in form, which were described by Mr. R. C. Taylor, (Amer. Jour. xxxiv, 88,) and again by Mr. S. Taylor, (ibid., xli, 21,) are regarded by the gentlemen of whose labors I have given you a sketch, as more modern structures, perhaps even of the present races of Indians, but this is by no means certain.

4. *Pipestone of the Ancient Pipes in the Indian Mounds*; by E. G. Squier.—With respect to the stone of which these pipes were made, some light appears to be thrown upon the locality where it was probably obtained, by Du Pratz, p. 179. The description could not possibly be more exact. As the book may not be at hand, I transcribe the passage.

"In this journey of M. de Bourgmont, mention is only made of what we meet with from Fort Orleans, from which we set out, in order to go to the Padoncas; wherefore I ought to speak of a thing curious enough to be related, and which is found on the banks of the Missouri; and that is a pretty high cliff, upright from the water. From the middle of the cliff juts out a mass of *red stone with white spots, like porphyry*, with this difference, that what we are speaking of is almost soft and tender like sandstone. It is covered with another sort of stone, of no value; the bottom is an earth like that on other rising grounds. The stone is easily worked, and bears the most violent fire. The Indians of the country have contrived to strike off pieces thereof with their arrows, and after they fall in the water plunge in for them. When they can procure pieces thereof large enough to make pipes, they fashion them with knives and awls. This pipe has a socket two or three inches long, and on the opposite side the figure of a hatchet; in the middle of all is the bort or bowl of the pipe to put tobacco in."

The cliff occurs it seems on the banks of the Missouri. The quarries of the *Coteau des Prairies* are at a long distance from the river. Further, the *white spots* mentioned, *speckling*, if I may use the term, the stone, do not occur in the pipestone of the prairie—at any rate in none of the specimens I have seen. And these white spots constitute one of the marked features in the stone of the mound pipes.

5. *Discoidal Stones;* by E. G. Squier.—I may add to the remarks in my paper on the Discoidal Stones, (p. 216,) that Du Pratz, p. 366, describes the game mentioned by Adair, fully explaining the purpose of the oblique-edged stones, figs. 1 and 5 of Dr. Morton. These when rolled would describe a convolute figure. Says Du Pratz—

"The warriors practise a diversion which is called the game of *the pole*, at which only two play at a time. Each has a pole about eight feet long, resembling a Roman f, and the game consists in rolling a flat round stone, about three inches diameter and an inch thick, *with the edge somewhat sloping*, and throwing the pole in such a manner that when the stone rests, the pole may touch it or be near it. Both antagonists throw their poles at the same time, and he whose pole is nearest the stone counts one, and has the right of rolling the stone."—*Du Pratz*, *p.* 366.

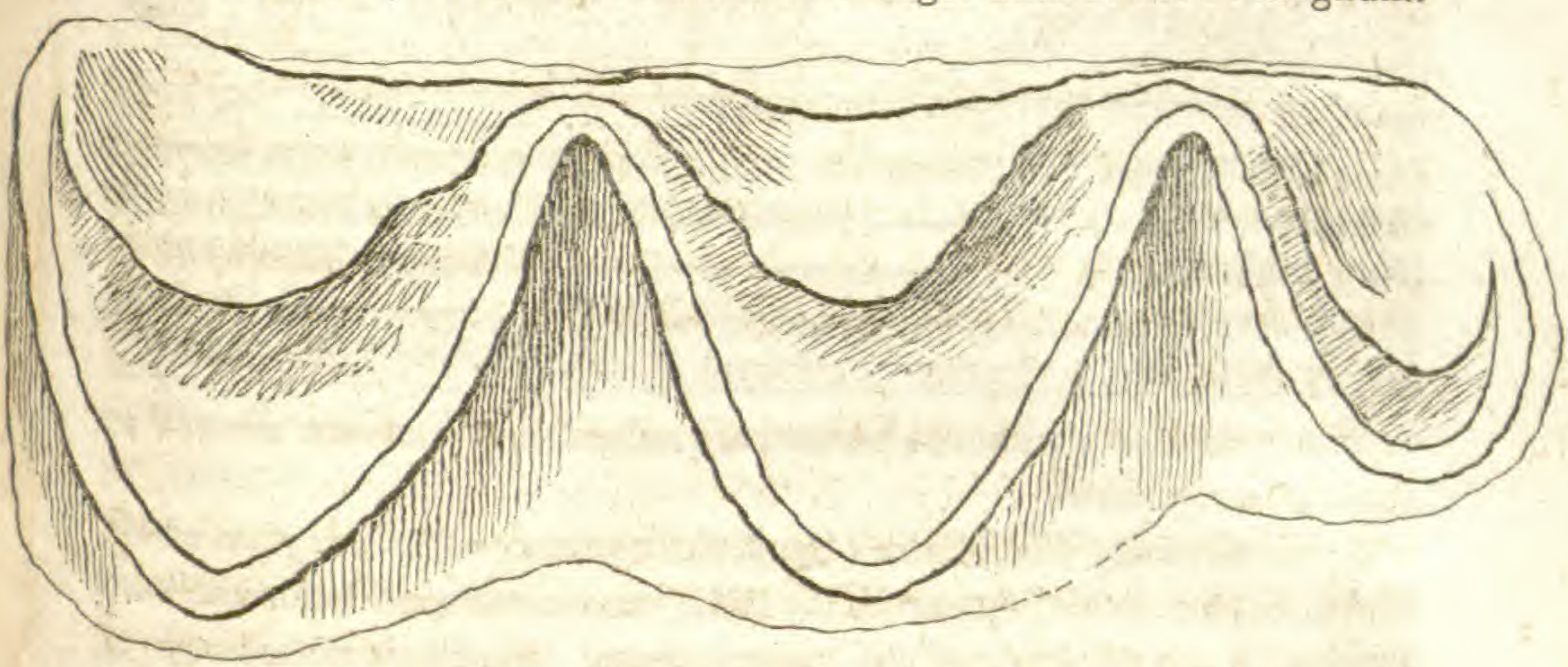
Mr. Brackenridge (Views of Louisiana, p. 256,) mentions a game popular among the Arikara, (Riccarees,) played with a *ring*, fig. 4 of Dr. Morton.

Lewis and Clark also describe a game, common among the Mandans, resembling the one above mentioned, which was played with stones of this description.

The two discoidal stones which were found by Mr. Chas. W. Atwater, in a mound near Huron, and mentioned by Dr. Morton, are unquestionably modern in their origin, as are also the other articles discovered by him; the human remains being those of the modern Indians—modern as compared with the great race of mound builders. It is a well known fact that the present race of Indians did, and to the west of the Mississippi still frequently do, bury their dead in the mounds, in conformity with the almost universal custom which leads them to select bluff points and the brows of hills for their burying places. It is therefore all important, in examining the mounds, that a proper discrimination should be made between the various deposits. The lack of it has already led to many errors and some amusing blunders. It may, I think, be laid down as an unvarying rule, that whatever human remains and deposits made with them, are found within two, or even four or five feet of the surface of the mounds, are those of the more recent races of the aborigines.

6. *Gigantic Palæotherium.*—We have recently received information from Mr. H. A. Prout, of his discovery of the remains of a Palæotherium in the tertiary near St. Louis, and we are also indebted to him for a cast of the jaw, a view of the posterior tooth of which is represented below. Mr. Prout is preparing a memoir on the subject; and in the mean time we state the following facts from his letter.

This fossil was found in the great northwestern tertiary belt, which is deflected from the north by the Black Hills, and which crosses the Missouri River at about latitude 43°. It was accompanied by several Baculites compressus, an Inoceramus concentricus, a vertebra of a large fish and some crystallized gypsum. The entire jaw bone, judging from the decrease in the size of the teeth, must have been at least 30 inches long, which far exceeds in size the Palæotherium magnum. The face of the posterior tooth, is $4\frac{5}{8}$ inches in length; and from the posterior side of the last tooth to the anterior side of the antepenultimate molar of the same side, the distance in the specimen is 11 inches. This is the aggregate length, in the line of the jaw, of but *three* out of *seven* teeth; and with the most liberal allowance for decrease of size in the other four, the whole of the seven could not have measured less than 16 or 18 inches, which is about one half larger than in the P. magnum.



Vertical view of the posterior tooth, belonging to the lower jaw of Mr. Prout's Palæotherium—natural size.

7. *Relative Quantities of Land and Water on the Surface of the Earth*; by Prof. S. P. RIGAUD, (Trans. Camb. Phil. Soc., vi, 289, 1837.) Prof. Rigaud obtained his results by cutting up the map paper of a three feet globe (one of Mr. Addison's), separating thus the land from the water, and weighing each parcel. Every precaution was taken to ensure accuracy, and full confidence may be placed, it is believed, in his results, excepting of course such errors as necessarily arise from ignorance of regions yet unexplored by man.

This mode of determining the proportion of land and water was used by Dr. Halley in 1693; and afterwards for the whole globe by Dr. Long, as published in his Astronomy, (1742,) Art. 580.

The following are some of the results arrived at by him. The sphere is supposed to be divided into 1000 parts, and out of them the ratio of land to water in the—

	Land.	Water.		
Whole sphere, ...	265·9233 . . .	734·0762	or	100 : 276*
Northern hemisphere, .	197·2153 . . .	302·7846	"	100 : 154
Southern hemisphere, .	68·7080 . . .	431·2916	"	100 : 628
Torrid zone, ...	98·7171 . . .	300·0318	"	100 : 304
North polar circle, . .	18·0263 . . .	23·4437	"	100 : 139
North temperate zone, .	126·6308 . . .	132·5247	"	100 : 105

* The late discoveries in the Antarctic region will require a correction of the ratio here given for the whole sphere. Dr. Long obtained for this ratio, omitting the polar circles, the ratio of 100 to 281.

	Land.		Water.		
North half of torrid zone, .	52·5582	...	146·8162	"	100 : 279
South half of torrid zone, .	46·1592	...	153·2156	"	100 : 332
South temperate zone, .	22·5488	...	236·6060	"	100 : 1049

Land.	N. Polar.	N. Temp.	N. Torrid.	S. Torrid.	S. Temp.	Total.
Europe, . .	0·9524	15·6989	———	———	———	16·6513
Asia and islands,	5·0329	65·5901	13·6039	3·9743	0·5308	88·7320
Africa, . .	———	10·2760	29·7231	15·7697	3·8076	59·5764
New Holland, .	———	———	———	6·0263	9·7063	15·7326
North America, .	12·0410	35.0658	3·4857	———	———	50·5925
South America, .	———	———	5·7455	20·3889	8·5041	34·6385

The waters of rivers and lakes were taken into account as well as those of the oceans.

8. *Eruption of Mt. Hekla*, (Lond. Atheneum.)—An eruption of Mt. Hekla commenced September 2, 1845, and continued with unabated fury, until the 2d April of the present year. There is no example of such a prolonged phenomenon in the annals of Iceland. Very singular consequences have ensued. The winds have carried the volcanic ashes all over the island, and the cattle are perishing, poisoned by the herbage which it taints and covers. The poison developes itself in singular forms of disease, and it is thought that if the eruption continued two months longer, all the cattle in the island must be destroyed, or abandoned to death by this strange malady. The eruption is described in fearful characters. The flames from each of the three craters were thrown up to a height of 2400 fathoms, and their width exceeded that of the greatest river in the island. The lava lay mountains high: and masses of pumice-stone weighing half a ton, had been carried a distance of a league and a half. The ice and snow of centuries, had all melted in the heat, and overflowed the rivers: and the Rangen, swelled also by the burning lava, left its finny tenants on its shores dead and cooked.

The Royal Academy of Sciences, at Göttingen petitioned the King of Hanover to send commissioners into Iceland, at the Government expense, for the purpose of observing this phenomenon; and two distinguished Geologists, Mess. Berez and Sartorius were nominated for that duty.

Since the eruption of the volcano has ceased, the whole southern portion of Iceland has been disturbed by frequent earthquakes.

9. *Vesuvius;* (Athenæum, July 18, 1846.)—Letters from Naples announce that Vesuvius is in full eruption, throwing out masses of lava and making the night magnificent with its spectacle.

10. *Australia.*—The late voyage of the Beagle under Commander J. L. Stokes, R. N., has resulted in the discovery of five rivers on the north coast, named the Fitz Roy, Victoria, Adelaide, Albert, and Flin-

ders. Victoria was much the largest, and its course was examined for 140 miles. The natives discovered on the banks are represented as fine, bold men, contrasting strikingly with the "miserable objects" seen at Sidney. The Albert and Flinders empty into Gulf Carpentaria. The former runs through a country of great beauty, the best seen in northern Australia. The farthest point reached was named the Plains of Promise, from the conviction that future explorers of the interior of this continent, must here take their departure. Capt. Stokes feels assured that with camels and little expense, the exploration would be easily effected.—*Discoveries in Australia, during a voyage of H. M. S. Beagle, under J. L. Stokes, Commander, 2 vols.*—Athenæum, June 27, 1846.

In South Australia valuable copper mines have lately been opened. The first was discovered at Kapunda in 1842, and to the close of 1845, no less than 1200 tons of ore had been sent to England. The ore is principally the sulphurets and carbonates of copper. The Montacute mine was opened in 1844, and is considered very promising. Still another mine of great extent has been since found in the vicinity of Razorback Mountain about 100 miles north of Adelaide.

11. *Mount Ararat;* (L'Institut, No. 649.)—M. Abich, who has lately been engaged in a scientific journey over Asia Minor, has discovered in the vicinity of Mt. Ararat, rocks of the era before the coal, and to the southeast of the valley of the Araxes, where in the middle of the river stands the island of rocks of Corvirab, he has detected *Sprifers*, *Terebratulas*, a *Productus* and *Crinoidea.* Hardly 20 versts from Ararat he collected the *Cyathophyllum flexuosum;* and not far distant, in the Daralagian Mountains, perpendicular beds filled with Productus, Orthis, and Crinoidea occurred surrounded by Jurassic beds containing small Exogyri. M. Abich will return to Ararat by the Mountains of Maku to complete his chart of the region.

12. *Museum of Natural History at Paris;* (Athen., July 11, 1846.) —The Chamber of Deputies has voted a sum of 136,786 francs for the acquisition of ground wanted for the purposes of the Museum of Natural History.

13. *M. Jacobi.*—This distinguished geometrician of Berlin has been elected to fill the vacancy in the list of foreign members of the Academy of Sciences at Paris, occasioned by the death of M. Bessel. The other candidates were MM. Brewster, Buckland, Herschel, Liebig, Melloni, Mitscherlich, and Tiedemann.

14. *Lavoisier*, (Athen. July 18, 1846.)—The founder of Chemistry, Lavoisier, was, as our readers know, snatched away by a violent and premature death, ere he had found time to collect and arrange his works. In 1843, the Minister of Public Instruction consulted the Acad-

emy of Sciences as to what works of that philosopher should be included in a national publication; and a committee was appointed to examine, and report on the matter. This committee has now made its report; and recommends that the Chamber of Deputies be asked for a sum of from 40,000 to 60,000 francs for the purposes of the publication according to its suggestions. It is only with the view of giving a national character to this edition of Lavoisier, as the Committee observe, that they apply to the State for its cost; for a member of the illustrious chemist's own family would gladly take upon himself the entire expense, and renounces his right to do so only because of the greater glory redounding to Lavoisier from the sponsorship of the Government.

15. *Leibnitz*, (Athen. July 18, 1846.)—The honors paid to the memory of Leibnitz, on the occasion of the two-hundredth anniversary of his birth, have not been confined to his native town, Leipsic. In that city, however, we must not omit to mention, the King of Saxony contributed to the celebrations the important one of the creation of a Royal Academy of Sciences. It is divided into two classes; the first including Natural Philosophy and the Mathematics—the second, History and Philology. Each class is to have twenty-five national members—residing either in the kingdom of Saxony or in the Saxon countries of the Ernestine line,—and a certain number of foreign associates and corresponding members. On the first occasion, the native members are, as in the Vienna Institution, to be named by the King—but after-vacancies will be filled up, in each class, by its own election. The Academy is to hold two public meetings yearly—one on the King's birthday, the other on that of Leibnitz. When these come too close together, the second public sitting is to be held on the 14th day of November, the anniversary of the philosopher's death.—At Hanover, where Leibnitz died, the occasion of the recent anniversary was marked by the opening to the public, for the first time, of the Chamber of Leibnitz, at the Royal Library. This room contains a crowd of objects which belonged to that philosopher—including many of his manuscripts, published and unpublished—his journal of the year 1696—his correspondence with the Duke of Hesse—the fauteuil in which he sat, and the book which he was reading, when struck by death. This book is the first volume of the works of Argenais de Barclai,—Amsterdam edition. M. Eccard, the pupil and friend of Leibnitz, has written in it, in Latin, the following note:—"The illustrious Leibnitz had in his hand, and was reading, this book, when, in the year 1716, the 14th day of November, an unexpected death overtook him. Witness, George Eccard." —The house in which Leibnitz lived, at Hanover, has been purchased by the Government,—and is to be called the *Leibnitz Museum*. There,

will be deposited all that may in future be collected relating to the deceased philosopher.

16. *Comet Medal*, (Athen., July 18, 1846.)—A letter from Prof. Schumacher, says, "The King of Denmark has offered the Comet Medal (20 Dutch ducats in gold) for the best discussion of Tycho's observations of the Comet of 1585. Prof. Gauss is appointed judge. The papers must be sent to me before July 1st, 1847, without name, distinguished by a motto only, and the name of the author in a sealed paper, inscribed with the same motto. You will find in No. 533 of the *Astronomische Nachrichten* all the information which can be required."

17. *Chinese Map*, (Athen., July 18, 1846.)—Amongst the articles brought from China by the Commission who have just returned from that country,—and which are exhibited at the Ministry of Commerce,—is a map of the world, presented to the Commission by the head Mandarin of Canton. The Chinese geographer has arranged the earth quite in his own way. With him, there are no isthmuses, no peninsulas; the Isthmus of Suez is replaced by a magnificent arm of the sea, which detaches itself from the Mediterranean to fall into the Red Sea. We see nothing of the Isthmus of Panama, and the two seas on that side are connected in the same way. There are neither Pyrenees nor Alps, and hardly are the vast mountains of America indicated. On the other hand, however, China is liberally dealt with by the geographer; for upon this point it occupies not less than three-quarters of the whole globe.—*Galignani.*

18. *M. Verneuil on the Fusulina in the Coal Formation of Ohio*, (in a letter to the editors of the Amer. Quart. Jour. of Agriculture, iv, 166.)—I have made in the carboniferous formations of Ohio a very interesting discovery for me, as a Russian traveler. The burrh stone, or mill stone of this country, is a siliceous band which occupies about the central part of the carboniferous series. This stone is full of small cavities, similar to the impression due to a grain of corn or wheat. These cavities, as I assured myself, have been filled by a small animal of the class of the Foraminifera, which Prof. Fischer has called in Russia, *Fusulina cylindrica.* You will easily understand the pleasure I felt to find my old traveling guide. In Russia, the Fusulina occupies principally the highest division of the carboniferous limestone, and here it is confined also to the coal series; but what is the most astonishing is, that in the old continent, the Fusulina is exclusively found in Russia, where it constitutes hills of two hundred feet, entirely composed of them. When you come to Germany or the British islands, the Fusulina is wanting; and so it had seemed to us that it was a being organized for eastern countries.

19. *Dr. Owen's Report on the Mineral Lands of the United States.* —This important document, which has been for six years sleeping in the archives of the Treasury Department at Washington, has at last been brought out with all its maps, plates of fossils, and picturesque views. The ground covered by this report contains about 11,000 square miles, and the results possess a high interest, both in a practical and scientific point of view. The time in which this great labor was performed seems incredibly short, and the fact that the work *was* done, and well done, is sufficient proof, not only of Dr. Owen's great energy, forethought and tact, but of his thorough fitness for the task, by previously acquired knowledge. He thus alludes to his labors:

"After duly weighing the nature of my instructions, estimating the extent of country to be examined, considering the wild unsettled character of a portion of it, and the scanty accommodations it could afford to a numerous party, (which rendered necessary a carefully-calculated system of purveyance,) and ascertaining that the winter, in that northern region, commonly sets in with severity from the 10th to the middle of November, my first impression was, that the duty required of me was impracticable of completion within the given time, even with the liberal permission in regard to force accorded to me in my instructions. But, on a more careful review of the means thus placed at my disposal, I finally arrived at the conclusion, that, by using diligent exertion, assuming much responsibility, and incurring an expense which I was aware the department might possibly not have anticipated, I might, in strict accordance with my instructions, if favored by the weather and in other respects, succeed in completing the exploration in the required time.

"I therefore immediately commenced engaging sub-agents and assistants, and proceeded to St. Louis; there (at my own expense, to be repaid to me out of the *per diem* of the men employed) I laid in about three thousand dollars worth of provisions and camp furniture, including tents, which I caused to be made for the accommodation of the whole expedition; and in one month from the day on which I received my commission and instructions in Indiana, (to wit, on the 17th of September,) I had reached the mouth of Rock River; engaged one hundred and thirty-nine sub-agents and assistants; instructed my sub-agents in such elementary principles of geology as were necessary for the performance of the duties required of them; supplied them with simple mineralogical tests, with the application of which they were made acquainted; organized twenty-four working corps, furnished each with skeleton maps of the townships assigned to them for examination, and placed the whole at the points where their labors commenced, all along the southern line of the western half of the territory to be examined.

Thence the expedition proceeded northward, each corps being required, on the average, to overrun and examine thirty quarter sections daily, and to report to myself on fixed days at regularly appointed stations: to receive which reports, and to examine the country in person, I crossed the district under examination, in an oblique direction, eleven times in the course of the survey. Where appearances of particular interest presented themselves, I either diverged from my route, in order to bestow upon these a more minute and thorough examination; or, when time did not permit this, I instructed Dr. John Locke, of Cincinnati, (formerly of the geological corps of Ohio, and at present professor of chemistry in the medical college of Ohio,) whose valuable services I had been fortunate enough to engage on this expedition, to inspect these in my stead.

"By the 24th of October, the exploration of the Dubuque district was completed, and the special reports of all the townships therein were dispatched to your office, and to the office of the register at Dubuque. On the 14th of November, the survey of the Mineral Point district was in a similar manner brought to a close; and by the 24th of November, our labors finally terminated at Stephenson, in Illinois; the examinations of all the lands comprehended in my instructions having been completed in two months and six days from the date of our actual commencement in the field. Also several thousand specimens—some of rare beauty and interest—were collected, arranged and labelled.

"The weather was favorable, and the winter did not set in with severity until about a fortnight later than is usual in that latitude; yet, the same day on which the survey was completed, a severe snow-storm occurred, a gale blew up from the northwest, the thermometer fell to 12 or 14 degrees below zero, and the expedition could not have continued its operations in the field a single day longer.

"The district of territory explored lies nearly in equal portions on both sides of the Mississippi river, between latitude 41 and 43 degrees; commencing at the mouth of Rock river, and extending thence north, upwards of 100 miles, to the Wisconsin river, which discharges itself into the Mississippi immediately below Prairie du Chien.

"The average width of this body of land exceeds 100 miles. It comprehends about 11,000 square miles, equalling in extent the state of Maryland."

We cite from the report at the present time only the following general remarks:—

"The general geological character of the country explored may be thus briefly summed up. It belongs to that class of rocks called by recent geologists *secondary*, and by others occasionally included in the *transition* series. It belongs, further, to a division of this class of rocks described in Europe as the mountain limestone, or sometimes as the carboniferous, or metalliferous, or encrinital limestone. And it belongs, yet more especially, to a subdivision of this group known popularly, where it occurs in the west, as the *cliff limestone*, and described under that name by the geologists of Ohio.

"This last is the rock formation in which the lead, copper, iron, and zinc of the region under consideration, are almost exclusively found; and its unusual development doubtless much conduces to the extraordinary mineral riches of this favored region. It therefore demands, and shall hereafter receive, particular analysis and attention.

"In the northern portion of the district surveyed, an interesting and somewhat uncommon feature in the geology of western America presents itself. I refer to the strata (of considerable depth) which crop out along a narrow strip of the northern boundary line of this district, and which are chiefly observable in the bluffs on both sides of the Wisconsin river; whence (if we may rely on the representations of Schoolcraft and others) they extend north, even to the falls of St. Anthony.

"These strata are interesting, first, as being the only instance known to me, in the valley of the Mississippi, in which the rocks underlying the blue limestone can be seen emerging from beneath it to the surface; and secondly, as apparently supplying an example of those alternations of neighboring strata, to which I have already alluded as being partial exceptions to the invariable order of geological superposition."

20. *Academy of Natural Sciences of Philadelphia.*—The usefulness of this institution, and the interests of science in general, have been greatly promoted by the munificent liberality of Dr. Thomas B. Wilson, a citizen of Philadelphia, and a member of the Academy. This gentleman has recently purchased, in Paris, the splendid collection of birds known as the *Rivoli Collection*; which is admitted to have few rivals, either in respect to the beauty or the variety of its specimens. The number exceeds 10,000, embracing 5,000 *species*, mounted and named, and illustrating all the diversities of plumage incident to the difference of age, sex and locality.

Dr. Wilson has not only become the proprietor of this remarkable collection; he has also resolved to place it in the Academy, where it will be accessible to the public, and thus diffuse the knowledge of one of the most pleasing branches of natural history. But the present Hall of the Academy, spacious as it is, is too small to accommodate this gigantic acquisition, and it therefore becomes necessary to extend the building, which can only be accomplished at a heavy expense. But Dr. Wilson, with a liberality that has few examples, has removed this obstacle, by authorizing the Academy to construct, at his sole expense, the requisite additions to the Hall, which are already in progress, and are to be completed early in the coming year. The main saloon, by this arrangement, will be one hundred and fifteen feet long by forty-five feet broad, admirably lighted, and fire-proof throughout.

We record with pride and pleasure this noble contribution to the science of our country; and we may justly and emphatically apply to Dr. Wilson, a remark that was made of William Maclure, the venerable founder and benefactor of the Academy:—"It is rare that affluence, liberality, and the possession and the love of science, unite so signally in the same individual."*

Obituary.—*Denison Olmsted, Jr.*, died of consumption at New Haven, Conn., Aug. 15, 1846, aged 22 years. Mr. Olmsted was a son of high promise of Prof. Olmsted of Yale College. He had already distinguished himself as a mineralogist and chemist, and had displayed uncommon ability as an original investigator. His devotion to mineralogy commenced at a very early age, while yet a school boy; and when but nine years old, he had made great proficiency in mathematics. He had been for two years prior to his death, in the chemical laboratory of Yale College, where his services were highly valued, and several of his analytical results have appeared in former volumes of this Journal. For a year before his death he held the post of chemist in the geological survey of Vermont, and within a few months he had been honored with an appointment to a similar situation in Canada.

He died, as he had lived, a Christian; and although the hopes of many have been disappointed, friendship could desire no happier termination of his labors.

Bonpland, (Lond. Atheneum.)—M. Aimé Bonpland, the celebrated naturalist, and fellow traveler of Humboldt, recently died at Corrientes, where he had resided since his release from Paraguay, where he was long held a prisoner by Dr. Francia, the Dictator.

Benzenberg, (Lond. Atheneum.)—M. J. F. Benzenberg died in the spring of 1846, at Dusseldorff, aged 67 years. In conjunction with the late Prof. Brandes, he undertook near half a century since, in a systematic manner, the investigation of the orbits of shooting stars; and the various works and papers which since 1798 he has published on this subject, have obtained much celebrity. He has also contributed memoirs on mathematics, natural philosophy and mineralogy. He has bequeathed to the town of Dusseldorff, the observatory which he had built, his rich collection of astronomical and other philosophical instruments, and the sum of 7000 thalers, the interest of which is to keep the apparatus in repair.

* Am. Jour. of Science, iii, 362.

Bibliography.

1. *A Treatise on Algebra;* by Elias Loomis, A. M., Professor of Mathematics and Natural Philosophy in the University of the City of New York, Member of the American Philosophical Society, of the American Academy of Arts and Sciences, &c. Harper & Brothers. 1846.

Many treatises on the elementary mathematics have recently appeared in this country. We are glad to see them. They indicate an increased attention among us to an important department of learning, and are, to a certain extent, demanded by the constant access of illustration which this department is receiving from the labors of European analysts.

In the work which Professor Loomis now submits to the public, he has aimed at exhibiting the first principles of Algebra in a form which, while level with the capacities of ordinary students and the present state of the science, is fitted to elicit that degree of effort which educational purposes require. We think he has been generally successful, and that the intrinsic merit of the work will concur with his official situation in securing to it the favorable attention of teachers.

The typographical execution of the work is good as far as page 192; where the type changes and becomes rather too small to suit a work designed for general use as a text-book. We have not found entire freedom from errors of the press, and it would be unreasonable to expect it. Throughout the work, whenever it can be done with advantage, the practice is followed of generalizing particular examples, or of extending a question proposed relative to a *particular* quantity, to the *class* of quantities to which it belongs: a practice of obvious utility as accustoming the student to pass from the particular to the general, the tendency to which constitutes the basis of the philosophic spirit and of all enlarged useful action,—and also as fitted to impress a main distinction between the Literal and Numeral Calculus, the superiority of the former as enabling us to treat of *classes* of quantities where we should otherwise be compelled to confine our view to individuals, and the immense assistance afforded by mere notation to the operations of the human intellect. The General Doctrine of Equations is expounded with clearness, and, we may add, with independence. The author has developed this subject in an order of his own; theorems which find a place in other treatises are omitted, and what sometimes appears in a generic form or in that of a corollary, becomes specific or assumes the place of a primary proposition. We venture to say that there will be but one opinion respecting the general character of the exposition.

2. *The Horticulturist;* by A. J. Downing.—The first number of this new monthly Journal was put on our table in July. It is devoted

to all horticultural and rural matters, architecture, and the literature of its own departments. The editor of this attractive Journal has earned a wide renown by his elegant and most useful works on Landscape Gardening, Cottage Architecture, and Pomology. As an original and accomplished author in these attractive and popular pursuits, he has no rival since the death of the indefatigable Loudon, and his merits have been acknowledged by marks of high consideration from some of the crowned heads of the old world. Under his conduct, and judging from the merits of the first number, the Horticulturist bids fair to run an useful and honorable course.

3. *M. D'Orbigny* has already brought out the first numbers of his new enterprize, as follows:—

(1.) *Paléontologie Universelle de Coquilles et de Mollusques, avec un Atlas représentant toutes les espèces de Coquilles Fossiles connues.* 1re livraison, 29 plates. Gide & Co., Rue de Petits-Augustines, 5.—This great systematic work is designed to contain all known species of fossil molluscs with a figure of each species. It will be completed in eight volumes of text, 8vo, with an atlas of about 1500 plates. Each livraison will contain 20 plates and the corresponding text, and costs 6 francs. Cost of the whole about 450 francs. This work will comprise all the plates of the "Paléontologie Française" of the same author, which has already reached 150 livraisons and about 600 plates, and is still in progress. In fact all that this voluminous author has done in these departments of Zoology, in his monograph of the Cephalopodes, his Geology of South America, his works on the Antilles, and numerous others, will be comprised in the Paléontologie Universelle. When finished, the Paléontologie Universelle will supersede all other systematic works in the department of geology which it covers.

(2.) *Mollusques Vivants et Fossiles, ou Description de toutes les espèces de Coquilles et de Mollusques classées suivant leur distribution Géologique et Géographique;* par Alcide D'Orbigny. 3 livraisons, with colored plates.—This work will form ten volumes in 8vo of text, with about 300 plates. It will appear in livraisons containing 5 plates and 5 folds of text, which will cost with uncolored plates each 3 fr. 50 c., and with colored plates 5 fr. The plates contain exquisitely engraved and colored figures of the typical species of each genus, as well as of those species which are most characteristic of each formation.

(3.) *Paléontologie des Coquilles et des Mollusques étrangers a la France;* par M. Alcide D'Orbigny.—This work is designed more particularly for circulation in France, and for those who have already possessed themselves of the *Paléontologie Française*. It contains only those plates which the last mentioned work does not, but the text of the Universal Paleontology complete.

We have received for distribution from the author, a supply of his prospectus with specimen plates, and also several copies of the first numbers of the two first mentioned works, as specimens of the style, and can supply all our friends who will make early application for them (post paid) to the address of B. Silliman, Jr. We have before mentioned that M. D'Orbigny, was desirous of procuring the works of all American writers on geology, and well labelled suits of fossils from our several formations. For these he will make an equivalent in any of his published works, or in French and Jurassic fossils. We trust that a number of subscribers to the Paléontologie Universelle will be found in this country, to aid in sustaining this Herculean enterprize. By the kindness of the author we have received a copy of several of his most important works, beside the foregoing.

4. *Leçons de Géologie Pratique, tome premier*, Paris, 1845, 8vo. —This volume comprises the first eleven lectures of the distinguished Elie de Beaumont, delivered at the college of France during the years 1843 and 1844. Several of the first lessons are devoted to preliminaries, descriptions of instruments, mode of observation, collection and preservation of specimens, &c. The lecturer commences with the loose material of the surface, the sands of the deserts and the sea. He then considers the phenomena of low lands in all parts of the globe, the mouths of rivers, and the great deltas of the Nile, Ganges, and Mississippi, with which the eleventh lecture closes. The work will be comprised in three similar volumes, of which the third is announced for August of this year.

5. *Works of M. Agassiz.*—We are favored with the continuation of several of the publications of this industrious author, whose works are not more numerous than they are excellent. We notice the following for the first time :—

(1.) *Matériaux pour servir* à une énumération aussi complète que possible des ouvrages publiés sur l'histoire naturelle, dès les temps les plus anciens jusqu' à ce jour, et que je me propose d'éditer plus tard sous le titre de *Bibliothèque Zoologique et Paléontologique.*

This is an alphabetical list, in folio, of authors and works, in all departments of zoology, general and comparative anatomy, physiology, the study of fossils, geology, all memoirs on chemistry and physique, which have any bearing on physiology or relate to the structure of the globe.

The sheets now issued of this gigantic undertaking are 282 in number, forming a ponderous folio, with a single column of letter press and a wide margin for additions. This issue is distributed by the author to those who will aid him in endeavoring to fill up and complete this great and most important labor. The intention is ultimately to issue a complete conspectus of the literature of the whole world in these departments of science. What is already done must be of infinite service to naturalists, and the coöperation of all is invited in endeavoring to render these lists as complete as possible.

(2.) *Iconographie des Coquilles Tertiaires*, 4to, 1845.—This memoir is devoted to the descriptions and figures of those tertiary fossils which are reported to be identical with living species, or with those in different strata of this epoch.

This memoir contains fourteen plates and twenty-eight species belonging to the four genera *Cytherea*, *Cyprina*, *Venus*, and *Lucina*.

(3.) *Notice sur la Successions des Poissons Fossiles;* folio.—This is an extract from the last livraison of the *Poissons Fossiles*, giving an account of the position of fossil fish in the series of geological formations. Also an essay on the classification of fishes.

(4.) *Tableau Général des Poissons Fossiles rangés par terraines*, par L. Agassiz.—This thin quarto (only 16 pp.) is a most important item to all students in this department, being a well arranged catalogue of all species of fossil fish known in 1844.

(5.) *Monographie des Poissons Fossiles du Vieux Grès Rouge.* (Old red sandstone) des iles Britanniques et de Russie, par L. Agassiz. Three parts of text in 4to, and three folio atlases of plates.—This work was undertaken at the request of the British Association at the Manchester meeting in 1842. Those who have followed Hugh Millar in his delightful wanderings "in an old field," will here recognize the grotesque forms and uncouth portraits of those progenitors of the finny tribes which characterize the "Devonian System." The work surpasses even the Poissons Fossiles in the splendor of its illustrations.

(6.) *Etude Critique sur les Mollusques Fossiles*, par L. Agassiz, 3 and 4 livraisons.—The former parts of this monograph we have already noticed. These two livraisons complete the genus *Mya* in 95 plates 4to, and accompanied by full descriptions.

(7.) *Nomenclator Zoologicus*, continens nomina systematica generum animalium tam viventium quam fossilium; auctor L. Agassiz.—We have already noticed* somewhat at length, in connection with the report of the British Association on the subject of nomenclature, this important labor of the Swiss naturalist.

The fasciculi vii. and viii. contain chiefly the Pisces and Hymenoptera, with additions to several of the previous families. The work will be complete in 12 fasciculi, and published without delay. It will when complete contain 31,000 names without the synonyms, each order being distinctly and separately paged and alphabetized. There will also be a full index to the whole work.

6. *Kunze's Supplement to Schkuhr's Carices;* part iv, contains figures and full descriptions of the following species, viz:—C. gynocrates,

* This Journal, 1st Series, xlv, 1.

Wormsk; C. Redouskiana, *Meyer;* C. crus-corvi, *Shuttlew.* Mss.; C. disperma, *Dewey;* C. Hochstetteriana, *Gay;* C. planostachys, *Gay;* C. Mairii, *Coss.* and *Germ.;* C. macrolepis, *D C.;* C. Durieui, *Steud.;* C. lucorum, *Willd.;* C. subulata, *Michx.;* of which the first is a native of the Arctic regions, and five others belong to the United States. The *C. crus-corvi* (from New Orleans, Drummond) is the same as the C. sicæformis of Boott, in the Journal of the Boston Natural History Society for January, 1845; we are uncertain which name has the priority. C. disperma is figured from specimens collected by Rugel in the mountains of Carolina; as also is C. lucorum, *Willd.*, which appears like a common state of C. Pennsylvanica. C. subulata is well represented, we believe from New Jersey specimens, communicated by Dr. Knieskern. A. Gr.

7. Drejer, *Symbolæ Caricologiæ Synonymiam Caricum extricandam stabiliendamque et affinitates naturales eruendas. Adjectæ sunt tabulæ æneæ XVII,* (Opus Posthumum ab Scient. Danica Soc. editum, pp. 40, imp. 4to, 1844.)—The late S. Drejer, of Copenhagen, author of the *Revisio Critica Caricum Borealium, etc.*, 1841, died just as he was rising into high reputation as a Caricologist, and while preparing more extended works upon his favorite genus. This posthumous production was doubtless intended as merely the first of a considerable series. Several interesting North American species are admirably represented in the plates, and of the natural size, viz. Carex Shortiana, *Dew.*, C. glaucescens, *Ell.*, C. Cherokeensis, *Schwein.*, C. stenolepis, *Torr.*, and C. squarrosa, *Linn.* We are glad to learn that the C. stenolepis of Torrey is to retain its name, the earlier homonym of Lessing being, as Drejer asserts, only a boreal and depauperate form of C. vesicaria. The introduction contains some good observations on the natural grouping of Carices, illustrated by three elaborate engraved tables.

A. Gr.

LIST OF WORKS.

Memoirs of the Geological Survey of Great Britain, and of the Museum of Economic Geology in London, vol. i, roy. 8vo, with wood cuts and 9 large plates. 1846, *London.* 21*s.*

Botanical Chart of British Flowering Plants and Ferns, by H. F. Knapp. 8vo. *London*, 7*s.* 6*d.* cl.

Nomenclature of Colors, by D. R. Hay, 2d edit. 4to. *London*, 1846. 35*s.* cl.

Bibliotheca Historico-naturalis, (containing a notice of the works on Natural History published in different parts of Europe during the past century, and ending with the middle of 1845,) by Wm. Engelmann. *Leipzig*, 1846.

Iconographie Ornithologique, (in illustration of the Buffon Series,) by Friedrich Klincksieck, Paris. Is issued in parts, in folio with 6 colored sheets, and also in quarto.

Handbuch der Mineralogie, A. Herr, Professor at Wetzlar. 8vo, *Frankfurt* bei Sauerländer.

Giornale toscano di Scienze mediche, fisiche, e naturali, diretto dai Professori G. B. Amici, Matteucci, Puccinnotti, G. Paolo Savi, *Pisa.*

Lehrbuch der Zoologie, Dr. A. Berthold. 8vo, 592 pp., 1845, *Göttingen.*

Lehrbuch der Vergleichenden Anatomie, von Pr. v. Siebold und Pr. Stannius, 1 heft, 1845, *Berlin.*

Phycologia Germanica, by Prof. Fr. Phil. Kützing. 8vo, 240 pp., 1845: *Nordhausen* bei Köhne.

Giornale botanico Italiano, compilato per cura della Sezione Botanica dei Congressi Scientifici Italiani du Filippo Palatore, *Firenze.* 1845.

Elmintografia umana, by S. delle Chiaje. 8vo, 264 pp. 1844, *Napoli.*

Systematische Uebersicht der Vögel Nordost-Africas von Dr. Rüppell; large 8vo, 144 pp, 50 pl., 1845. *Frankfurt,* bey Schmerber.

Atlas de Cranioscopie, ou dessins figuratifs de Crânes et de faces de personages célèbres ou remarquables, by Dr. C. G. Carus; (also in German.) *Leipzig,* 1845.

Petrefaktenkunde Deutschlands, by Prof. F. A. Quenstedt. Large 8vo, *Tubingen,* 1846.

Ueber einige bömische Trilobiten, by Dr. Ernst Beyrich. Large 4to, *Berlin,* 1845.

SCIENTIFIC RESEARCHES.

Proceedings of the Academy of Natural Sciences of Philadelphia; May, 1846. Page 51. Two new species of Echinodermata from the Eocene of the United States; S. G. Morton.*—Page 52. New species of Bat from Western Africa; E. Hallowell.†—Page 53. New Coleoptera of the United States; F. E. Melsheimer. (Genera—Cantharis, Zonitis, Nemognatha, Ischnomera, Nacerda, Xylophilus, Melandrya, Hypulus, Seraptia, Hallomenus, Orchesia, Eustrophus, Eryx, Allecula, Mycetocharus, Cistela, Helops, Trachyscelis, Neomida, Platydema, Hypophœus, Uloma, Iphthinus, Blapstinus.)—Page 66. A new Physa, and remarks on Glanderia cylindracea; J. S. Phillips.——*June,* 1846. Page 72. Anatomy of the abdominal viscera of the Sloth (Bradypus tridactylus); J. Leidy.—Description of Unio abacoides; S. S. Haldeman.‡

Proceedings of the Boston Society of Natural History, July, 1846.—Page 121. Analysis of the glassy scoria of Kilauea; J. Peabody.—Page 123. Notice of the deposits on the Chatahoochie River, Georgia; J. H. Couper.—Page 124. On the trap and sandstone of the southern shore of Lake Superior; H. D. Rogers.—Page 126. On the Natchez Bluffs; A. Binney.—Page 131. Drift on the Hill called Mount Washington, at South Boston; C. Stodder.—Page 132. Remarks on the Mollusca of Jamaica; C. B. Adams.

Proceedings of the Providence Franklin Society, vol. i, No. 1. Catalogue of Rhode Island plants; S. T. Olney.

Annals and Magazine of Natural History, June, 1846, No. 114. Natural History of the Malayan Archipelago, by P. J. Begbie, noticed at length by H. E. Strickland.—New Entomostraca, with a plate; W. Baird.—Corynactis, a new genus of Helianthoid Zoophytes, with a plate; G. J. Allman.—Zool. Soc. Proceedings, Nov. 25, 1845. New Helices from the collection of H. Cuming; Dr L. Pfeiffer.—Dec. 9, New Land Shells from Jamaica; Dr. L. Pfeiffer.——*July, No.* 115. *Proceedings Zool. Soc.,* Jan. 13, 1846. A new Nyctibius; Mr. Gould.—Jan. 27, Dissection of the Chimpanzee, R. Owen.—New species of Pleurotoma from various regions; L. Reeve.—Feb. 24, Osteology of the Active Gibbon, Hylobates agilis; E. Fry.—Eleven new Australian Birds; J. Gould.——*July, No.* 116. On

* See this Number, p. 273. † Ibid. ‡ Ibid., p. 274.

the circulation of the sap in the interior of cells; H. von Mohl.—On the cell membrane of plants; G. H. K. Thwaites.—New Orthopterous and Homopterous Insects, with a plate; Adam White.—On certain genera of Shells of the class Palliobranchiata, (Terebratulæ, &c.); W. King.—Four new Longicorn Beetles, with a plate; A. White.—Descriptions of the Mymeridæ; F. Walker.—A new family and genus of Lizards from Columbia; J. E. Gray.—*Zoological Society*, March 10. New species of Cypræa; L. Reeve.—March 24, Size of Blood Corpuscles in Birds; Mr. Gulliver.—Thirty new Helices, belonging to the collection of H. Cuming; L. Pfeiffer.

Hooker's London Journal of Botany, for June, 1846. New Hepaticæ; Th. Taylor.—New genus of Hydrophyllaceæ from California; Dr. Harvey.—Notes on a Journey in the interior of Southern Africa; Ch. L. Zeyher.

Annales des Sciences Naturelles, *for January*, 1846. *Zoology*. Description of the galls of Verbascum and Scrophularia, and the insects which inhabit them; Leon Dufour.—On the apparatus of respiration of Birds; Natalis Guillot. *Botany*. On a new genus of Cycadeæ of Mexico; Ad. Brongniart.—Note of Dutrochet relative to objections brought by Trecul against his opinion respecting the development of adventitious roots.—On the structure of old trunks of Cycas circinalis; M. Miguel.—On stems which descend towards the earth like roots; M. Dutrochet.—On a new genus of Paronchieæ, Dicheranthus; P. Barker Webb.—Revision of the genus Poterium; Edw. Spach.—Twelfth notice on the Cryptogamic plants of France; M. Desmarières.—Memoir on the relations of Noggerathia to living plants; Ad. Brongniart.—Monstrosities of Antirrhinum majus and other plants, by Mélicocq.

Societe Philomatique de Paris. Session of May 9, 1846. Sur l'organization des Vers; M. Blanchard, (L'Institut, No. 645, p. 163, and No. 646, p. 172.)

Memoires de la Soc. Roy. des Sciences de Liege, tome i, part 1, 1843. Page 85. Review of the species of Cicindelæ, with descriptions of some new species; Th. Lacordaire. Tome ii, part 2, 1844. Page 261. Two new Bulimi from Columbia; H. Nist.

Academie der Wissenschaften zu Berlin. Session of Nov., 1845. On the microscopic life of Portugal, Spain, South Africa, Lower India, Japan and Kurdistan.——March, 1846. On the structure of the Ganoid fishes; Hr. Müller.—On the uncrystalline silica in plants, and a Spongilla in Silesia, and their relation to the infusorial earth of Berlin deposits; Hr. Ehrenberg.—Note on the Spirifera and Terebratula; von Buch.

Akademie der Wissenschaften zu Göttingen. Session of Aug. 2, 1845. On new or rare reptiles of New Grenada, and on the Crustacea of China; M. Berthold, (L'Institut, No. 644, 1846, p. 156.)——Feb. 11, 1846, on three new Scorpions from New Grenada.

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THE

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[SECOND SERIES.]

Art. XXVIII.—*On the Sabbatic River*; by W. M. Thomson.

Josephus in the 5th Chapter of his 7th Book on the Jewish War, gives the following description of this remarkable river.

"Now Titus Cæsar, tarried some time at Berytus, as we told you before. He then removed and exhibited magnificent shews in all the cities of Syria through which he went, and made use of the captive Jews as public instances of the destruction of that nation. He then saw a river, as he went along, of such a nature as deserves to be recorded in history. It runs in the middle, between Arca belonging to Agrippa's kingdom, and Raphanea. It hath somewhat very peculiar in it; for when it runs its current is strong, and has plenty of water, after which its springs fail for six days together, and leave its channel dry as any one may see; after which days it runs on the seventh day as it did before and as though it had undergone no change at all. It hath also been observed to keep this order perpetually and exactly—whence it is, they call it the Sabbatic River—that name being taken from the sacred seventh day of the Jews." This is the account of Josephus. Pliny* mentions this river, as is generally supposed; but he seems to imply that it ran six days and rested on the seventh. "In Judea rivus sabbatis omnibus siccatur." Pliny thus makes the river a more consistent Jew than does Josephus.

* Nat. Hist. 31, 2.

The translator of Josephus says that this famous river is now extinct: and in this opinion the learned Reland in his Palestina Illustrata concurs. And Galatinus rather sarcastically argues against the Talmudists, that—"If this river while it existed was a sign that the sabbath ought to be observed, now since it never appears, the sabbath should no longer be kept." Niebuhr, the celebrated Danish traveler, having discovered an independent tribe of Jews residing in Arabia, says—"The circumstances of this settlement have perhaps given rise to the *fable* of the Sabbatical River." What the "circumstances" were which could have given rise to such a fable, he does not mention; nor is it easy to discover, or even imagine. I believe however that the long lost river is at length found; and if this can be established, we shall not only demolish the odd argument of Galatinus against the perpetuity of the sabbath; but rescue the Jewish historian from the imputation of gravely recording idle fables.

To return to the quotation from Josephus. Titus it appears made rather a protracted stay at Beirût. He then traveled north to Zeugma on the Euphrates, dragging after him crowds of Sion's most miserable captives, whom Josephus says he everywhere exhibited as public instances of the destruction of this nation. Now it was in this march northward from Beirût, that he saw the Sabbatic River. It ran between Arca and Raphanea, in the kingdom of Agrippa. The latter part of this sentence I apprehend has extinguished the river, or at least started all travelers on a fruitless search for it. They have endeavored to find it somewhere in, or near to the kingdom of Agrippa; and as there is an Arcea and a Raphanea between Palestine and Egypt, they naturally have sought for the river there. But it is plain that we cannot hope to find it in that direction, and for two good reasons. *First*, because there is no such river there; although I read many years ago the journal of a traveler through the desert from Egypt to Jerusalem, who suggested that a wide channel or *wady* which exhibited signs of having, at times, a great volume of water—though perfectly dry when he crossed it—might possibly be the lost Sabbatical River. To any one however who has either resided or traveled in Syria, there is nothing remarkable in the dry channel of a wide stream. They are common in all parts of that country. The *second reason* is, that the narrative of Josephus absolutely requires that the river should be at a considerable distance north of Beirût. Titus was on his march towards Antioch when he noticed it. The river could not therefore have been in Agrippa's kingdom; and I think it not improbable that the words, τῆς Ἀγρίππα βασιλείας, are an interpolation of some transcriber or scholiast, intending to make the description of Josephus more definite, by limiting it to the Arca and Raphanea in the south of Palestine—the only cities of that name probably with which he was acquainted. Nor would such a geographical mistake be at all surprising. For ages, Syria was a kind of *terra incognita.* Few even of the learned knew that there was such a place as Beirût in existence; and fewer still had any accurate information as to its relative position. A transcriber therefore might very readily suppose it to be in Agrippa's kingdom, and so add the explanatory clause. The Jewish origin of the name might suggest the same thing.

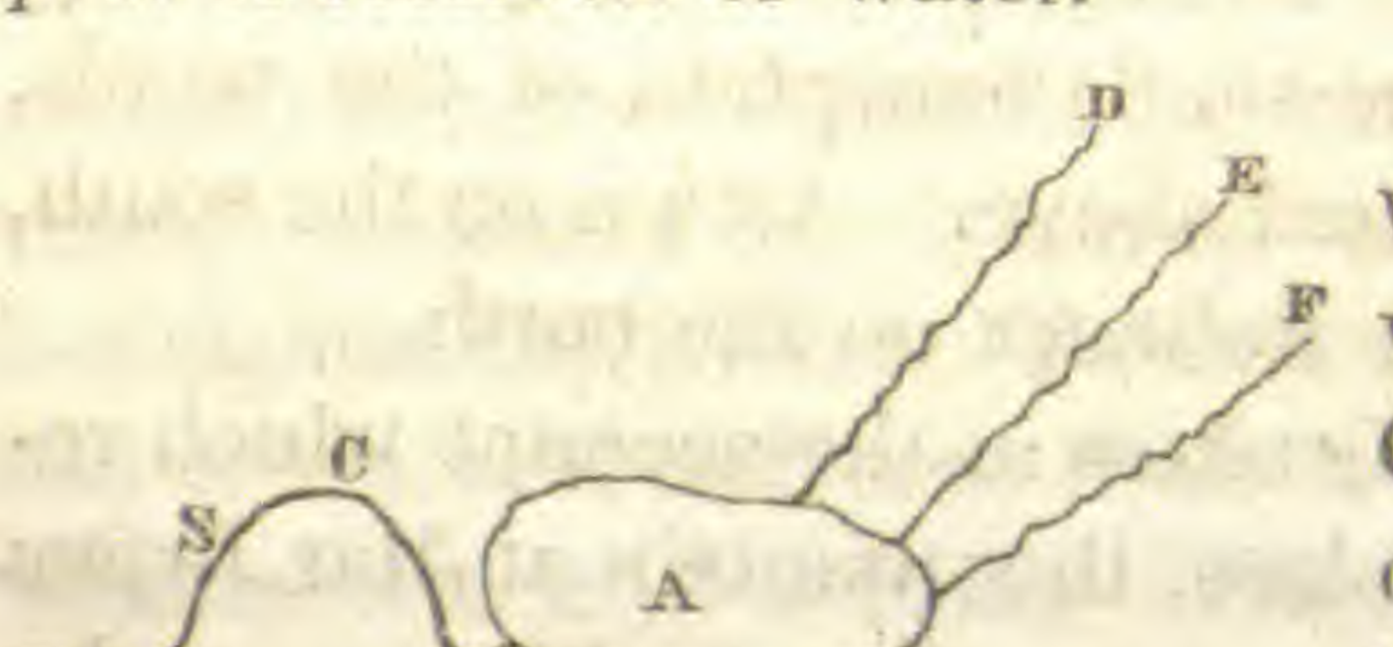
This much however is certain. If Titus saw the river on his tour northward of Beirût, we must travel in the same direction to find it. Accordingly, about half a day's ride to the north of Tripoli, (or three days north of Beirût,) there was a well known ancient city called Arca or Arcea; and a few miles farther north, a town called Raphanea. *Between* these two places, no doubt, flowed the Sabbatic River. In all probability this river derived its origin and peculiar character, from one of those intermitting fountains which are to be met with occasionally in different parts of the world, and of which there are several examples in Syria. This necessary supposition will guide to the precise spot where our river first appears.

In the valley below the Kulâat Hûssn, and near the great convent of Mar Jirjius, there is a fountain which throws out at stated intervals an immense volume of water, quite sufficient to entitle it in Syria to the name of river. And it is in fact the head or source of one considerable branch of the Nhr el Kebîr, the ancient Eleutherus. This locality answers, in all respects, to the description of Josephus, with the single exception of the words, "in Agrippa's kingdom," explained above. Arca is on the south, and a village called Raphanea or Rahanea on the north.

There are however some difficulties in the account which require explanation. In the first place, this fountain at Mar Jirjius *is now*, as I was informed, quiescent *two days* and active on the *third.* The account given me on the spot was, that every third day St. George descended, and forced out the water with loud roaring, and great violence, to irrigate the extensive plantations of this richest of Syrian convents. I examined the cave out of which the river flows, through a wide low aperture. It is situated at the base of a limestone hill or rather mountain. This limestone hill is isolated—entangled in an almost boundless region of trap rock. It was one of its resting days, when I visited the cave; but I noticed very evident traces, in the bed of the river below, of the large volume of water which had rushed along it only the day before.

According to Josephus, the river ran on the seventh day, and rested during the week; but Pliny reports that it flowed six days, and was dry on the seventh. At the present time it rests two days and runs on the third. To reconcile these discrepancies, we need not suppose either that the river (having grown old during 1800 years) requires twice as much rest as when Josephus wrote; or that St. George doubled the number of working days in order the better to irrigate his gardens. Both historians probably derived their information from general rumor, and had not visited or examined the river for themselves. And the numbers in both versions of the story were adopted, from a desire to connect so singular a phenomenon with the Jewish division of time. It is highly improbable that either of them is strictly accurate; and this has been the common opinion of the learned, without having the river itself to refer to, the actual conditions of whose activity and repose require such a supposition.

If we must admit, however, that one or the other of these statements was literally exact, (and certainly they could not have both been true,) the difference betwixt the periods of activity and intermission eighteen hundred years ago, and at the present time, admits of a satisfactory explanation. I believe it is now well ascertained that these intermitting fountains are nothing more than the draining, on the principle of the syphon, of a subterranean pool or reservoir of water.



Let A represent such a reservoir, under the mountain upon which stands the convent of St. George; S the syphon, which of course must commence at the bottom of the pool, rise over an elevation, as at C, as high as the water rises in the pool, and terminate lower than the pool, at B. D, E, F, represent small rills which fill the pool. Now the condition necessary to make the stream issuing at B intermit, is that the capacity of the syphon S be greater than the small rills D, E, F, can supply. If the supply were greater, or exactly equal to the capacity of the syphon, the pool would always be kept full, and of course no intermission could occur. The periods of intermission, as well as the size of the river, depend upon the capacity of the reservoir A, the supply from D, E, F, and the *caliber* of the syphon, S. If it required six days for D, E, F, to fill the pool, and the syphon could exhaust it in one day, you have the conditions required by the statement of Josephus, a river running only on the Sabbath. If D, E, F, fill the pool in one day, and their continued supply is so nearly equal to the draining capacity of the syphon as to require *six* to exhaust it, then you have the river running six days, according to Pliny's account, and resting on the *seventh*. The fact *now* is, if my information be correct, that the supply fills the pool in about two days and a half, and the syphon draws it all off in half a day.

If the account of Josephus was strictly true when he wrote, one of the following changes must have occurred, during the eighteen hundred years that have since elapsed. Either the supply from D, E, F, must have so increased, as to be able to fill the pool in two days and a half, and the capacity of the syphon so enlarged as to exhaust the pool with its triple supply of water in half the time it formerly did; or, the supply, and the capacity of the syphon remaining unchanged, the size of the reservoir must have been reduced to about one third of its ancient dimensions. The former supposition is not probable in itself and is discountenanced by the consideration, that in the time of Josephus the amount of water was so great as to obtain the name of *river*, and it can only claim that title now by courtesy. But we may readily admit that the pool may have been partly filled up by debris, or by the falling in of its superincumbent roof of rock. If Pliny's account were true, then either the supply must be greatly diminished, or the reservoir greatly enlarged, for according to him, it required but one day of rest to fill the pool, while now it takes two days and a half. Either of these hypothetical changes is possible, but neither of them very probable. Nor are we compelled to resort to any of them. I suppose the Sabbatic River was always nearly what we find the stream at *Mar Girgius* now to be. And the vagueness of general rumor, the proverbial love of the ancients for the marvelous, and the desire to conform this natural phenomenon to the Jewish division of time, will sufficiently account for the statements of these great historians.

The following circumstance corroborates the general correctness of the preceding statements, which were drawn up after my first visit to the convent of St. George in 1840. In October, 1845, I again had occasion to visit the same part of Syria, and had opportunities to make farther inquiries in regard to this remarkable river. Having visited and examined the ruins of the magnificent temple at Arca, I traveled across the country towards the north, along or near to the line of the ancient Roman road, according to the itineraries and old geographers. At length I came to the *dry* channel of a wide stream, coming down from the mountain on which the convent is built. As I expected, the peasants informed me that its source was at the cave below the convent. After traveling two or three hours farther north I crossed another river, called Abrosh, or Leper's River, on the banks of which there is an ancient site, still called Rahanea, which is exactly the Arabic pronunciation of the Raphanea of Josephus.

I spent the night with an old Sheikh of the Ansairiyeh at a village about twenty miles to the west of the convent. The Shiekh was not only acquainted with the fountain, which he called Nebã el Fûãr, but immediately gave to the stream itself the name of Nhr Sebty, or *seventh day river*. And he insisted that it ran only once every seven days, although I knew to the contrary. But, in accordance with his own religion, he made it a *moslem*, declaring that it flowed only on *Friday*. From some such Sheikh as this, Josephus (or Titus) may have received his account eighteen centuries ago, as he passed along this road. Nor ought it to be regarded as very wonderful, that traditions should be handed down, in the east, for so many generations, unchanged. We have the very *names* of the places preserved unaltered, and why not the singular tradition connected with them.

My traveling companion on the latter tour, Capt. Newbold of the East India army, subsequently made a visit to the convent of St. George, solely to examine this river. He is fully convinced of its identity with the Sabbatic River of Josephus. He however understood the monks to say that the periods of intermission varied with the rainy and dry seasons of the year. This is very probably correct.

ART. XXIX.—*On Three several Hurricanes of the American Seas and their relations to the Northers, so called, of the Gulf of Mexico and the Bay of Honduras, with Charts illustrating the same;* by W. C. REDFIELD.

(Continued from Vol. II, p. 187.)

Phenomena of the Cuba Hurricane and Cotemporary Storms.

EFFECT OF THE GALE'S ROTATION ON THE BAROMETER.—The extraordinary fall of the mercury in the barometer which takes place in gales or tempests, has attracted attention since the earliest use of this instrument by meteorologists. But I am not aware that the principal cause of this depression had ever been pointed out, previously to my first publication in this Journal, in April, 1831; when I took the occasion to notice this result as being obviously due to the *centrifugal force* of the revolving motion found in the body of the storm.*

Since that period, inquiries have been continued by meteorologists in regard to the periodical and other fluctuations of the barometer, and the relations of these fluctuations to temperature and aqueous vapor.† But these incidental causes of variation in the atmospheric pressure prove to be of minor influence, and we are left to the sufficient and only satisfactory solution of this marked phenomenon which is found in the centrifugal force of rotation.

In the Cuba Hurricane, the fall of the barometer may now be viewed in its obvious relations to the known rotation of the gale. In the previous Tables, I, II, and III, the reader may have noticed the depressing effects of the centrifugal force at different distances from the storm's axis and in the various stages of its activity and progression. These tables enable us to determine, approximately, *the mean of the barometric curve, through the central portion of the storm, transversely to its path,* as shown by the lowest observations obtained during its progress, which may be grouped as follows:

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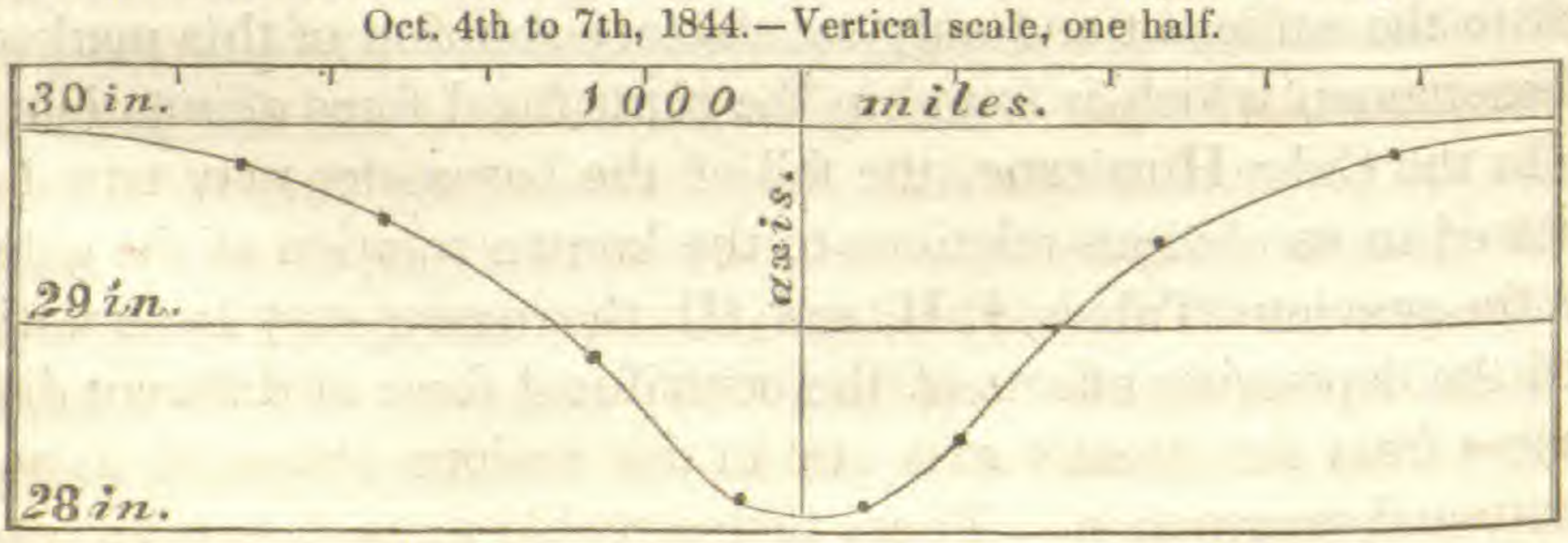
* This Journal, xx, 45–46.

† It is apparent that hygrometrical observations made at the earth's surface cannot show the relative condition of the higher strata of air, which move, as currents, in different directions, with a rapid progression, and have different geographical and hygrometrical relations. Nor can observations at mountain stations resolve the difficulty; for these must commonly have relation to the inferior stratum of air which has ascended the mountain slope.

On the left side of the storm path, the lowest observations found in recitals 45*a*, 75, 97, 106, 109, 114, 126 and 135, at points varying from 305 to 400 miles from the axis line and at an average distance of 349 miles, afford us a mean of 29·76 inches. At most of these points, as at others, the true minimum doubtless occurred between the times of observation, but only in 45*a* is a subtraction of ·12 in. made on this account. Recital 118, at a distance of 260 miles, shows 29·50 in., probably within an hour of the true minimum. Recitals 4, 6, 11*b*, 38, 81, 124, 133, 141, 142 and 144, in positions from 69 to 168 miles from the axis and at an average distance of 126 miles, show an average minimum of 28·84 inches. On the *center path*, as per Chart, the average minimum, as per recitals 34, 51, 148, 129 and 130, is 28·13 inches. On the right hand side of the path, recitals 19 and 64, at a mean of 98 miles from the axis, show an average minimum of 28·45 inches. The *Pioneer* (62) at 230 miles gives 29·45 inches:—and at Bermuda, at 375 miles, being a station where the barometer shows an annual mean of at least 30·16 in., our lowest observation is 29·86 inches. These several elements afford us the approximate curve which is here annexed.

Fig. 5.

Mean Barometric Curve across the centre of the Cuba Hurricane, transversely to its path, Oct. 4th to 7th, 1844.—Vertical scale, one half.



It is worthy of remark that the barometric depression in this gale does not appear to increase according to the increase of latitude; showing that the proper effects of the centrifugal force of rotation are constantly found on the *center path* of the storm, in all latitudes.

The mean barometric curve on the center path, in the direction of the storm's progression, appears not to differ essentially from that given above, so far as may be inferred from the various observations, except that on the posterior side of the storm the return of pressure, at some places, was apparently more rapid than

CHART IX. *Showing the Daily Progress of the Cuba Hurricane, with the Direction of Wind at the hour of 9 P.M. on the 5th 6th & 7th days of October, respectively. 1844.* CHART IX.

The numbers show the places or vessels named in the recitals.

Engd by J.M. Atwood N.Y.

its previous reduction. The contrary of this effect is sometimes seen in other storms.*

Thus, during successive days of the storm's greatest activity, and while passing through twenty-five degrees of latitude and near twenty-three degrees of longitude, we find an extraordinary barometric depression, the intensity of which increases rapidly as we approach towards the axial area of this great progressive whirlwind, coinciding, also, most remarkably, with the progress and intensity of the whirling action. We find, too, that the greatest intensity of the hurricane, and of its influence on the barometer, has no necessary connexion, or coincidence, with the local point of greatest rain or condensation; as clearly appears from recitals 38, 148, and other reports. Nor can any such coincidence at all lessen or contravene the known centrifugal force of rotation. To deny the proper influence of this force in rotatory storms, would appear equivalent to a denial of the great law of matter and motion to which the term is applied.

The same law of centrifugal action must tend to produce an accumulation of pressure beyond the verge of the active whirlwind, or at least in the areas or spaces which separate distant storms; a result which we have already viewed, in another connexion, in the two October storms of 1842 and 1837. In the present case, the barometric curve, in front of the hurricane as well as laterally, is found to blend with the more advanced and extended depression of the first Cuba gale;† and if we view the two centers of depression as comprised in one great area of gyrative influence, the accumulated exterior pressure, or summit of the barometric wave, will appear to be strongly exhibited, over a vast extent of surface, previous to the arrival of the storm. This is apparent from the various recitals previously given, and is shown more extensively by the barometric observations comprised in Table IV, which is annexed.

* It may be noticed that the barometric depression in this gale does not appear to increase according to the increase of latitude; showing, that the proper effects of the centrifugal force of rotation are truly shown in the center path of the storm, in all latitudes.

† See Plate XI, figs. 21 and 22.

TABLE IV.—Height of the Barometer (corrected for elevation) at the hours of 9 A. M. and 9 P. M., or other nearest hours of observation, for seven days in October, 1844; together with the highest and lowest observations made in this period.—In the daily columns, only the excess of 28 inches is noted, 2 inches being thus the equivalent of 30 inches of the barometric scale.

Places, numbered for order of progression.	Dist.fr. axis l.	Lat.	Lon.	Feet ab.tide	Oct. 1st. A. M.	Oct. 1st. P. M.	Oct. 2d. A. M.	Oct. 2d. P. M.	Oct. 3d. A. M.	Oct. 3d. P. M.	Oct. 4th. A. M.	Oct. 4th. P. M.	Oct. 5th. A. M.	Oct. 5th. P. M.	Oct. 6th. A. M.	Oct. 6th. P. M.	Oct. 7th. A. M.	Oct. 7th. P. M.	Lowest obs. 1st g.	Lowest obs. 2d g.	Rain.	Inches.
Fort Snelling (15)	1350	44° 53′	93° 08′	850 ft.	2·18	2·12	2·12	2·07	2·05	2·05	2·10	2·03	2·	2·05	2·16	2·16	2·21	2·05	29·98	30·03	None	
Fort Crawford (14)	1200	43 3	90 53	642	2·28	2·29	2·20	2·14	2·07	2·04	2·08	2·06	2·08	2·06	2·16	2·16	2·23	2·23	30·04	30·06	None	
Fort Gibson (10)	1160	35 47	95 10	600 ?	2·30	2·27	2·30	2·23	2·28	2·17	2·13	2·06	2·07	2·03	2·04	2·05	2·22	2·22	30·05	30·03	None	
Fort Towson (9)	1090	33 33	95 05	600 ?	2·19	2·20	2·22	2·15	2·18	2·04	2·05	1·95	1·96	1·80	1·93	1·86	2·06	2·10	29·92	29·80	None	
Fort Brady (20)	1040	46 39	84 43	600	2·37	2·39	2·04	1·78	1·62	1.74	1·93	1·95	1·91	2·	2·20	2·16	2·19	2·06	29·61	30·16	2–3d,	·46 in.
Jeff. Barracks (13)	990	38 28	80 08	390	2·38	2·26	2·29	2·16	2·12	2·01	2·05	2·01	2·06	1·93	2·06	2.12	2·28	2·23	29·96	30·03	None	
Fort Jessup (7)	885	31 30	93 47	270 ?	2·17	2·22	2·15	2·12	2·17	2·14	2·21	2·14	2·14	2·11	2·15	2·15	2·12	2·11	30·13	30·13	None	
Natchez (8)	850	31 34	91 25	270	2·34	2·25	2·27	2·25	2·18	2·08	2·06	1·99	2·	1·98	1·94	1·93	2·16	2·20	29·99	29·89	None	
Detroit (17)	800	42 24	82 28	580	2·32	2·31	2·23	2·03	1·89	1·83	1·95	1·93	1·99	2·04	2·10	2·12	2·12	2·15	29·83	30·12	2–4th,	·15
N. Orleans Bar. (6)	730	29 57	90 05		2·32	2·31	2·29	2·26	2·16	2·13	2·05	2·03	2·08	2·04	2·10	2·02	2·32	2·26	30·03	30·01	None	
Toronto Obs. (21)	700	43 39	79 21	342	2·46	2·36	2·22	1·91	1·75	1·70	1·69	1·67	1·79	1·87	2·05	2·03	2·11	2·10	29·66	30·03	2–3d, rain	
Buffalo (19)	660	42 53	78 56	620	2·27	2·43	2·36	2·13	2.92	1·79	1·84	1·76	1·86	1.95	2·08	2·10	2·14	2·10	29·76	30·10	2–4th,	·46
Rochester (22)	635	43 08	77 51	506	2·34	2·37	2·36	2·26	2·13	1·96	1·76	1·62	1·75	1·83	1·92	1·79	1 90	2·11	29·62	29·79	2–5th,	·76
Fort Barrancas (5)	620	30 18	87 12		2·20	2·17	2·19	2·23	2·16	2·07	2·07	2·01	2·02	2.07	1·99	2·03	2·08	2·08	30·03	29·96	nt. 6th,	·30
Sackett's Harbor (24)	580	43 57	76 04	240	2·43	2·37	2·33	2·13	2·03	1·89	1·79	1·60	1·68	1·94	2·11	2·11	2·10	2·13	29·60	30·10	3–5th,	·85
Plattsburgh Bar. (31)	520	44 41	73 26	240 ?	2·39	2·35	2.42	2·39	2·03	1·91	1·77	1·78	1·60	1·73	2·01	2·03	2·19	2·19	29·60	30·09	3–5th,	1·18
Carlisle Bar. (18)	490	40 12	77 10	473	2·45	2·50	2·41	2·29	2·11	1·94	1·84	1·78	1·78	2·01	2·13	2·05	2·05	2·16	29·76	30·05	3d,	1·55
Augusta Ars. (12)	470	33 27	81 35	370	2·23	2·28	2·25	2·20	2·15	2·10	2·04	1·90	1·92	1·98	1·90	1·92	1·94	2·15	29·90	29·90	None	
Hanover, N. H. (30)	460	43 41	72 22	360	2·40	2 50	2·48	2·28	2·16	2·	1·80	1·51	1·60	1.84	1·98	1·96	1·99	2·11	29·51	29·85	3–4th,	2·85
H. M. S. *Pique*,* (35)	415*	49 35	64 30						2·24	2·19	2·18	2·02	1·36	1·19	1·40	1·90	1·50	1·19	29·16	29·19	5th, *r.*; 7th, *r.*	
Amherst, Mss. (27)	410	42 22	72 28	290	2·44	2·42	2·47	2·35	2·22	2·10	1·82	1·69	1·64	1·83	2·02	2·02	1·99	2·10	29·62	29·92	3–4th,	1·98
New York (23)	400	40 43	74 01		2·53	2·48	2·49	2·34	2·17	1·94	1·73	1·69	1·82	1·89	2·06	1·84	2·05	2·18	29·66	29·84–	4th, slight *r.*	
Worcester (28)	375	42 16	71 47	376			2·40	2·28	2·03	1·99	1·70	1·47	1·53	2·07	1·89	1·84	1·73	1·94	29·35	29·61–	3–4th, 2·49; 7th,	·21
Hamden, Me. (32)	365	44 42	68 56	180			2·49	2·60	2·43	2·30	2·08	1·50	1·49	1·68	2·03	2·04	1·85	2·14	29·47	29·85–	4th, ·95; 7th,	·54
Boston (29)	345	42 20	71 05		2·30	2·38	2·40	2·34	2·20	1·96	1·90	1·48	1·55	1·79	1·92	1·79	1·83	2·03	29·47	29·79–	4th, 1·34; 7th,	·74
Fort Monroe (16)	345	37 02	76 12		2·61	2·55	2·53	2·55	2·22	1·99	1·87	1·81	2·06	2·07	2·	1·86	2·16	2·28	29·81	29·82	None (?)	
Charleston, S. C. (11)	335	32 46	79 46		2·35	2·40	2·35	2·25	2·11	2·	1 90	1·85	1·95	2·	1·80	1·95	2·10	2·20	29·85	29·80	None	
Fort Adams, R. I. (25)	325	41 28	71 23		2·41	2·44	2·47	2·39	2·21	2·	1·68	1·60	1·64	1·84	1·98	1·79	1·88	2·	29·60	29·77–	4th, 2·1; 7th,	1·
Fort Brooke, Fl. (3)	305	27 57	82 35		2·61	2·61	2·16	2·16	2·07	2·03	1·94	1·95	1·89	1·79	1·86	1·94	2·07	2·	29.93	29·79–	2d,	·10
St. Augustine (4)	305	29 40	81 35		2·18	2·22	2·18	2·18	2·16	2·	1·92	1·86	1·91	1·83	1·85	2·10	2·13	2·10	29·86	29·75–	5th, rain	
Nantucket (26)	260	41 15	70 06		2·30	2·30	2·29	2·27	2·15	2·	1·55	1·50	1·56	1·58	1·85	1·85	1·70	1·85	29·50	29·50	4th, shs.; 6–7th,	1·50
Halifax (flag sh.) (33)	168	44 36	63 28							2·19	2 09	1·92	1·54	1·55	1·73	1·80	1·50–	1·59	29·48	29·23	4–5th, *r.*; 7th, *r.*	
H. M. S. *Scylla* (34)	132	44 21	63 ?				3·20		2.40		2·20		1·30		1·75		0.90		29·30–	28·90	4th, *r.*; 7th, *r.*	
Key West (2)	120	24 27	81 50		2·13	2·08	2·04	2·	1·97	1·93	1·87	1·82	1·54	1·59	1·98	2·16	2·18	2·22	29·93	29·13	2–5th,	13 50 !
Matanzas (1)	50	23 03	81 15		1·60				1·		1·		0·		1·80				29· in.	28· in.	4–5th, heavy *r.*	

* The *Pique's* position in the *second* gale was about 130 miles left of the axis line, in lon. 61° 18′.

This table is taken from a fuller one, so as to suit the dimensions of the printed page; and the field of observation will be seen to comprise a breadth of thirteen hundred and fifty miles on the left side of the axis path of the hurricane. An approximate correction has been made for the known or supposed elevation of the stations in the interior, at the assumed rate of one tenth of an inch of mercury for ninety feet. The places stand in the order of distance from the axis line, beginning with the most remote; and the order of succession in the storm's course, parallel to this line, is indicated by the numbers affixed in the first column. As there is room for but two daily observations, those of the military posts are given for 9 A. M. and 9 P. M., as dividing the time into equal periods, and in other reports the times nearest to these hours are taken. The Toronto observations, only, are reduced for temperature to 32° Fahr.

The observations made at Bermuda, Newfoundland, and on board the *Trent*, (2*c*) at Vera Cruz, and the *Prince Albert*, (164) in lon. 38° 30′, (the latter being six hundred and fifty miles to the right of the axis line,) should also be included with those in the table.* Our barometrical survey is thus extended to two thousand miles, laterally to the path of the hurricane, and over more than thirty degrees of latitude, and fifty-six degrees of longitude.

During the progress of the two associated Cuba storms they are seen to have been immediately preceded, over this vast field, by a barometric wave or accumulation of pressure, rising above the usual or annual mean. An approach to this condition is seen

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* The observations at St. John's, Newfoundland, are entitled to an additive correction of 16 in. for 140 feet of elevation. The elevation of the barometer at Bermuda is not known; but another barometer, observed by an officer at the naval station, ranged from 30·46, on the 1st of October, to 30·07 on the 4th. Winds S. S. E. veering to W. S. W. on the 4th and 5th; and S. S. E. veering to W. on the 6th aud 7th.

The importance of establishing a station for meteorological observations at Bermuda, like those which have been instituted by the liberal enterprise of the British government at various other points, appears enhanced by the favorable character of this position, in the open sea, free from all continental and important local influences, and so nearly on the line of equal division between the polar and equatorial areas of the earth's surface. Perhaps the great height of the barometer at Bermuda, and the characteristics of the winds at that place, when these are accurately determined, may afford some additional knowledge of the laws of atmospheric circulation and distribution.

also on the left flank of the two storms, and in the rear of the hurricane. But the decided inequality which thus appears in the wave of maximum pressure in front of these storms as compared with their left border, together with the early disappearance of any excess on this border, in the Atlantic states, after crossing the thirty-first parallel of latitude, will be understood better when we take into view *another storm* which this extended inquiry brings to our notice. I will only remark here, that the areas or waves of cumulated pressure which are thus found between distant storms, as well as the gyrative character of the storms and their extensive barometrical depressions, appear entitled to special consideration in estimating, relatively, the mean barometrical conditions of different zones of the same polar hemisphere.

Cotemporary Storm of the Great Lakes.—The inspection of Table IV and other observations leads me to notice another storm, as above mentioned, the central portions of which passed over the basin of the great American lakes, and the St. Lawrence, cotemporaneously with the progress of the first Cuba gale. The first decided barometric indication of this storm, we obtain at Fort Brady, at the outlet of Lake Superior, on the 2d of October; from whence, advancing at the rate of about twenty-two miles an hour, we find its influence extending over the northern parts of the United States, Canada, and Nova Scotia, crossing the Gulf of St. Lawrence, and coinciding in part, with the phenomena of the first Cuba storm.* Its action, though widely extended, appears at first to have been moderate; and it was accompanied with light rain, which extended over Michigan and a part of Ohio, Pennsylvania, New York, and a large portion of the New England states. As the storm advanced in its course, its activity appears to have increased, and its barometric curve, blended with that of the first Cuba storm, becomes deeper, and, after a partial rising, is found to merge in the marked depression which attended the Cuba hurricane.

We may suppose that these different storms continued to pursue their several distinct courses, each crossing obliquely the path of another. Perhaps, too, the progress of this storm from the lakes might avail us in explaining more perfectly the origin of

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* The effects of this storm on the southern borders of Lake Michigan were noticed in the newspapers of that period.

CHART X. *Showing the Daily Progress of the Cuba Hurricane with the Direction of Wind at midnight, end of 6th and 7th days of October respectively, 1844.* CHART X.

The numbers show the places or vessels named in the recitals.

Engd by J.M.Atwood, N.Y.

the group of storms which appeared on the European coasts about the 10th of October.

LOCAL CURVES OF PRESSURE DURING THE PROGRESS OF THE SEVERAL STORMS.—The barometric observations at various points on or contiguous to the track of the Cuba hurricane from the 1st to the 7th or 8th of October, in the order of distance from its center-path, are delineated on Plate XI, fig. 21. This order of axial distance cannot be combined with that of the storm's progression, but the latter order is indicated by the numbers annexed to the several places of observation. The rising of the barometer, after its depression in the first Cuba storm and that of the lakes, is here seen to have been interrupted or prevented by the depressive effect of the hurricane which followed. In the first storm the fall of the barometer is seen to increase, northward of the Carolinas, in approximating with the route and the wide spreading influence of the storm from the basin of the great lakes, so that from New York to the mouth of the St. Lawrence the barometric depression was greater than was subsequently found in the left margin of the succeeding hurricane. In fig. 22, Plate XI, the same barometric curves are all adjusted to one point of advance in the Cuba hurricane, for the purpose of facilitating the comparisons. The several distances from the axis line are noted in the right hand column.

The importance of these extended observations, as affording some explanation of the causes and character of the irregular barometric undulations which occur in temperate latitudes, induces me to exhibit, in fig. 23, Plate XI, a delineation of the local curves in the track of the *third* or Lake storm; showing, as we approach the seaboard, the united barometrical effects of at least two storms as they are found converging in their course. The distances of the several places of observation from Halifax are noted on the Plate, beginning at Lake Superior. The route of this Lake storm appears to have been nearly parallel to that of the storm of Nov. 11th, 1835; which is found on Chart I, marked XI.

Thus it appears that two different storms may at one period in the course of their progression, be found moving in the same geographical area, even when their several places of origin have been greatly distant from each other. Their convergence in such cases, may result from different courses of progression, as well as from the convergence of the lines of longitude at increased distances from the equator, and may be aided in some degree by the greater horizontal expansion or diffusion of the several storms which is often found to take place in the higher latitudes.

Distribution of Temperature during the Storms.—Though unable to detect any controlling or characteristic influence of temperature in the development or progression of great storms, other than is involved in the induced or the incidental phenomena of these storms, I present here a summary view of the thermometric observations made in the extensive region under review, during the observed progress of the two Cuba storms. So many of the observations obtained as can be comprised on a single page are shown in Table V, which follows:—(See page 319.)

In presenting the observations from the military posts, in this table, I have taken those of sunrise and 3 P. M. because they are accompanied by observations of the wet bulb thermometer; although the observations made at 9 A. M. and 9 P. M. might afford better indications of the thermometric effects induced by, or attending, the storm. The observations from other places, when taken at 6 A. M. are deemed as nearly equivalent to those for sunrise at the beginning of October, and those for 2 P. M. or 2·30 as being sufficiently accordant with those made at 3 P. M. The observations made at other hours are so specified in the first columns of the table.

Temperature of Winter Storms.—If there be any appreciable results shown in Table V, they are perhaps found in a slight reduction of the local temperature in the areas of the two Cuba storms, while south of Cape Hatteras, and an increase of the local temperature when in the higher latitudes, as also in the storm from the lake basin. In colder months, and particularly in the winter season, a marked increase of temperature in the heart of the storm is commonly observed in the United States and Canada. This increase appears to result, mainly, from the geographical distribution of temperature in the different seasons and from the revolving and progressive character of the several storms. For it will readily be seen, that on the approach of a great storm from the lower latitudes by the usual routes, while revolving from right to left, ↺, its first effect will be to bring in the warm and humid air of a more southern region; and when the axis of the gale has passed, the contrary result necessarily follows and is in-

TABLE V.—Showing the state of the Thermometer at 6 A. M., (or at sunrise,) and at 3 P. M., with the daily mean, from the 1st to the 8th of October, inclusive, 1844; with some observations at other hours, as indicated in the body of the table.

Places.	Oct. 1st.					Oct. 2d.					Oct. 3d.					Oct. 4th.				
	Sun r.	3 P.M.	Daily mean.	Wet bulb.		Sun r.	3 P.M.	Daily mean.	Wet bulb.		Sun r.	3 P.M.	Daily mean.	Wet bulb.		Sun r.	3 P.M.	Daily mean.	Wet bulb.	
Fort Snelling	44°	68°	56°	43°	57°	48°	64°	56°	48°	50°	44°	59°	51·5°	41°	50°	34°	58°	46°	34°	50°
Fort Crawford	45	70	57·2	42	57	56	59	62	53	60	47	60	53·2	44	59	43	62	52·2	41	57
Fort Gibson	54	77	65·1	50	67	64	82	73·1	60	70	53	79	66·5	50	65	49	85	67·2	46	74
Fort Towson	51	75	63	45	46	61	77	64	59	68	56	82	69	55	67	45	83	64	42	44
Fort Brady	34	59	46·5	34	55	50	57	53·5	50	55	44	52	48	44	51	46	51	48·5	45	49
Jeff. Barracks	54	64	59	50	54	61	72	66·5	55	63	55	70	62·5	48	56	51	64	57·5	43	55
Fort Jessup	42	68	55	36	60	43	67	55	40	60	41	84	67·6	45	75	52	85	68·5	46	76
Natchez	55	66	(noon)			59	71				64	73				63	71			
Detroit	42	70	56	40	50	50	64	57	47	58	46	54	50	43	50	46	56	51	44	52
New Orleans	55	78	66·5	51	68	59	82	70·5	54	71	60	82	71	55	71	63	82	72·5	56	61
Toronto Obs.†	31	55	45	34	48	41	60	52·4	41	57	44	60	54	44	55	44	54	50·4	43	51
Buffalo	31	62	46·5	31	62	43	68	55·5	42	67	56	64	60	56	63	47	61	54	46	60
Pittsburgh Ars.	44	64	54	43	56	45	64	54·5	44	56	55	64	57·5	54	57	44	55	49·5	44	42
Pensacola	58	84	71	54	64	62	82	72	58	70	62	78	70	58	70	62	84	73	58	60
Sackett's Harbor	26	54	40	25	52	30	64	47	30	63	50	56	53	50	55	53	57	55	52	55
Plattsburgh	50	62	56	46	57	55	68	61·5	52	64	44	60	52	42	58	52	64	58	50	61
Carlisle Bar.	54	65	54·5	44	57	56	64	60	46	56	56	68	62	47	54	62	64	63	54	56
Augusta Ars.	52	72	62	51	64	60	76	68	58	70	64	79	71·5	60	71	65	73	69	64	55
Hanover, N. H.	30	60	(1·30 P. M.)			21	58	"			43	56	"			52	54	"		
H. M. S. *Pique*											9 A. M. 50·5; 9 P. M. 56					9 A. M. 53; 8 P. M. 56.5				
Amherst, Mss.	29	54	41·5			26	58	42			44	61	52·5			55	63	59		
New York*	48	62	55	44	52	50	63	56.5	49	56	54	65	59·5	52	62	60	67	63.5	58	63
Worcester						29	69	(2 P. M.)			42	58	50			58	66	62		
Hamden						27	50	38·7			43	51	47·7			54	58	55·7		
Boston	40	56	48			36	57	46·5			49	61	55			59	64	61·5		
Fort Monroe	53	68	60·5	51	61	63	68	65·5	58	65	64	69	66·5	61	63	62	69	65·5	59	64
Charleston, S. C.	60	73	66·5	55	64	67	75	71	60	66	69	73	71	64	65	67	75	61	62	59
Fort Adams	45	56	50·5	43	51	46	57	51·5	45	52	53	60	51·5	51	58	61	68	64·5	61	63
Fort Brooke	68	75	71·5	65	72	73	80	76·5	70	76	72	80	76	70	75	73	78	75·5	71	74
St. Augustine	74	78	76	72	76	76	77	76·5	73	75	74	80	77	72	77	70	79	74·5	67	72
Nantucket	52	54	{ 9 A. M. &			53	59				59	60				61	64			
Halifax†			3 P. M. }													52	58	54·5		
H. M. S. *Scylla*		(noon only)					52					54					56			
Key West	79	83	81	76	80	78	78	78	76	76	79	78	78·5	78	76	76	75	75·5	75	75

Places.	Oct. 5th.					Oct. 6th.					Oct. 7th.				
	Sun r.	3 P.M.	Daily mean.	Wet bulb.		Sun r.	3 P.M.	Daily mean.	Wet bulb.		Sun r.	3 P.M.	Daily mean.	Wet bulb.	
Fort Snelling	39°	57°	48°	39°	57°	36°	62°	49°	36°	52°	37°	67°	52°	37°	55°
Fort Crawford	42	60	51	40	57	41	58	49·2	40	55	39	64	51·2	40	55
Fort Gibson	57	81	69·2	55	71	17	76	61·5	44	63	58	74	66·2	51	66
Fort Towson	48	88	68	42	50	50	83	66·5	44	50	55	71	63	48	42
Fort Brady	45	48	46·5	44	45	34	50	42	34	46	30	55	42·5	30	50
Jeff. Barracks	47	63	55	39	55	53	70	61·5	48	63	48	60	54	40	52
Fort Jessup	61	82	71	54	78	62	88	75	54	80	55	69	62·5	48	62
Natchez	58	70				66	77				58	69			
Detroit	45	58	51·5	42	54	46	62	54	42	56	33	68	51·5	31	60
New Orleans	53	77	65	49	64	56	79	67·8	53	66	65	79	72	59	69
Toronto Obs.†	48	52	48.8	46	47	18	67	57·5	43	50	33	47	39·2	32	42
Buffalo	43	54	48·5	43	53	41	54	47·5	62	53	40	43	44	40	47
Pittsburgh Ars.	48	59	53·5	46	53	48	55	51·5	53	46	40	55	47·5	38	49
Pensacola	52	82	67	52	60	52	74	63	50	58	60	78	69	56	60
Sackett's Harbor	49	52	50·5	40	52	42	46	44	41	44	42	50	48·5	42	50
Plattsburgh	48	59	53·5	46	57	46	56	51	43	53	34	50	42	31	46
Carlisle Bar.	54	68	61	42	58	53	64	58·5	46	56	46	56	51	44	48
Augusta Ars.	56	72	64	55	67	56	70	63	55	65	55	74	64·5	54	64
Hanover, N. H.	49	59	"			15	52	"			42	46	"		
H. M. S. *Pique*	9 A. M. 55; 3 P. M. 57					9 A. M. 54; 3 P. M. 55					8 A. M. 56; 3 P. M. 57				
Amherst, Mss.	43	55	49			37	51	44			43	50	46·5		
New York*	52	65	58·5	49	61	50	56	53	44	56	48	55	51·5	47	50
Worcester	46	60	53			43	57	50			43	50	46·5		
Hamden	53	60	54·7			46	55	49·7			43	43	42·2		
Boston	59	63	61			48	51	49·5			46	52	49		
Fort Monroe	58	68	63	56	60	64	64	64	59	60	54	66	60	53	58
Charleston, S. C.	60	71	65·7	53	59	62	72	67	54	59	67	73	70	58	63
Fort Adams	54	64	59	52	59	52	60	56	50	55	45	56	50·5	45	51
Fort Brooke	71	74	72·5	68	70	67	75	71	64	71	59	80	69·5	58	76
St. Augustine	71	74	72·5	68	73	64	74	69	62	70	64	73	68·5	57	70
Nantucket	61	60				59	61				48	52			
Halifax†	59	62	54·2			54	62	55·7			50	49	48		
H. M. S. *Scylla*		62					60					56			
Key West	73	72	72·5	75	72	76	79	77·5	72	73	72	84	78	65	77

* At Fort Columbus.

† Observations taken every two hours, night and day; and the daily mean of the whole is given; but at all other places the daily mean as between 9 A. M. and 3 P. M. is copied, and appears not always correct.

creased, apparently, by the subsidence or vorticular depression of the higher and colder currents on the posterior or western side of the gale. Indeed, this rising of the thermometer during the access of winter storms, and its great depression as they pass off in their northeasterly courses, might in itself afford us good proof of the storm's rotation, were more direct evidence wanting.

In summer, when the geographical distribution of temperature on the path of the storm is more equal, the case is greatly altered, and a sinking of the thermometer is not unfrequently noticed in the earlier portions of the storm. The mean temperature of the several storms, is then often below that of the periods between the storms. Thus, while the general course and revolving character of North American storms, at all seasons of the year, are essentially the same, the phenomena and ranges of their temperatures are greatly varied in the different seasons.

Winds of the two Precursory Storms.—The axis of the first Cuba gale, in its early progress, seems to have advanced on a more inflected route than that of the subsequent hurricane, and having passed to the southward and westward of the island of Jamaica, it appears to have crossed the north shore of Cuba at some point eastward of long. 80°. It seems to have partially abated in its visible force in approaching the parallel of 30°, at least on its left and central portions, till it arrived near lat 40°, from whence onward it appears increasing in activity and extension. Its revolving character, when below the tropics, seems fully made out by observations on its different sides; and, during its course in higher latitudes, its right hand portion presents nearly the same winds and consecutive changes that characterized the like portion of the Cuba hurricane. Its more central portions also, exhibited southeasterly winds, followed in the higher latitudes by northwesterly; while, in the eastern states of the American Union, its northerly winds appear to have been partly intercepted by the passing storm from the lakes, and by the closely following hurricane; a result which I have several times observed, in similar cases.

In regard to the winds of the Lake storm, it may suffice to notice that they were chiefly southeasterly in the earlier part of the storm, in the basin of the great Lakes, and northwesterly or northerly during its later periods;—sometimes strong, and at other times weak and fluctuating in direction. At Plattsburgh, a gale

BAROMETRIC CURVES AS OBSERVED IN THE STORMS OF OCTOBER 1842.

PLATE XI.

Fig. 21. *Local Barometric curves during the progress of the two Cuba Gales in October 1844.*

Fig. 22. *The same Barometric curves adjusted to one point of progress.*

Fig. 23. *Local Curves in the Route of the Lake Storm in its approach to the Routes of the Cuba Gales.*

Vertical scale one half. Each principal line indicates 30 inches; the interval to the next line, one inch. — a marks the minimum of the first gale — b the minimum of the Hurricane or second gale.

at S. E. is noted on the 4th,—winds strong from S. W., N. E. and N. W. on the 5th,—and northwesterly on the 6th. In more southern portions of this storm the winds were southerly, and southwesterly, for the most part,—passing to the W. and N. W. The subsequent state of the storm in approaching the Atlantic, may be seen in the previous recitals, at stations where the effects of this and the first Cuba gale appear as partially blended, or as closely succeeding each other. Numerous observations which were made in New York and other states, at this period, are omitted for want of space; but these appear to afford no additional facts or views requiring our consideration.

In overland storms of this character, where but little force is found in the surface winds, attempts to map out the true vortical course of the storm-wind by means of the local observations will be but partially successful. This difficulty may be owing in part to the want of symmetrical uniformity in the revolving action, and to the diversities of the positions and elevations, over the face of a great continent or island, as well as to the intrusion of other winds, stratiformly, in the same geographical area. Thus the true horizon of the storm-wind may be but imperfectly noted, in the assemblage of observations, and different strata and fluctuations of the aërial currents be represented to our view as being in the same plane of movement. These and other causes of discrepancy and want of conformity in the winds, the enquirer may be wholly unable to classify or detect. Strongly characterized as was the Cuba hurricane, we have seen, clearly, the intrusion of other winds beneath the true horizon of the storm, in the New England states. Indeed, too much reliance may be placed upon mere observations of the surface winds, in meteorological inquiries. But the falling of the barometer in the storm, and the direction, strength, and order of succession of its principal winds, on one or both sides of the storm-path, will commonly afford sufficient evidence of its essentially revolving character.

Lake Gale or Hurricane of October 18th, 1844.—Two weeks after the occurrence of the Lake storm above noticed, a very violent and destructive gale passed over the basin of the great Lakes, on a course which also nearly corresponds to No. XI, on Chart I. Its effects were eminently destructive to the vessels on the Lakes, and also in the town of Buffalo, and during its further progress, it was severe also in Maine, Nova Scotia and the estuary of the St. Lawrence. At New York, and, generally, in the interior of the continent, the anterior winds of this gale were felt but moderately, though, at Toronto, the barometer fell to 28·86; the violence of wind, at the surface, being chiefly in the posterior side of the storm, on the rising barometer, as is the case in most of our overland gales, and in many of those on the Atlantic. This common feature of the Lake storms greatly enhances the value of the barometer, in navigating these inland seas.

Relations of the Cuba Gales to the Northers of Honduras and Yucatan.

Having previously shown that a portion of the great storms of the United States and the Atlantic ocean are identified with the Mexican Northers, several of which have been traced to the Atlantic,* it remains to notice a like identity of the Northers of Yucatan and Honduras with the storms which sweep over the island of Cuba and the Atlantic ocean. The common name of Northers has been applied to the gales which visit the northern coasts of Central America, as well as to those of Mexico, as far eastward as the Musquito coast and gulf and near to lon. 80°, over which region they are found frequently to occur, except in the summer months. The swell from these Northers is often injurious in ports of this coast which are sheltered from their immediate force.

From the Musquito coast to Cape Honduras, (lon. 83° to 86°,) when the wind gets "to S. E. and then veers to S. and S. W., a gale will surely succeed." These gales are very violent, and occur more frequently from W. S. W., west, and N. W., than from north.—Upon the Musquito shore, Honduras, and the eastern coast of Yucatan, the general winds are frequently interrupted in February and March by *norths.* In September, October, November, December, and January, the winds are from the northward or southward of west, [northwesterly or southwesterly,] with frequent gales from W. S. W., W., N. W., and north.—On the north-

* The events of the present year, (1846,) have served to bring to our notice the frequent occurrence of the Northers in the countries and on the coasts which border the Mexican sea, and their subsequent progress to the Atlantic as revolving gales, not only during the winter season but in the months of May, June, and July. Indeed, it would be an error to suppose that American storms or gales are limited, in their occurrence, to any one portion of the year. The great gale of the Atlantic coast, Sept. 8th—10th, since the foregoing was in type, was also a norther from the Gulf of Mexico, where it caused the loss of the steamer *New York,* and other vessels on the 6th and 7th.

ern and western coasts of Yucatan, the general winds are interrupted by hard Northers, in the season of them.*

That these northers of Central America move in a regular course of progression, like other storms, cannot well be doubted. In the case of the *Racer's* gale, we have seen that the course corresponds with the westerly progression of hurricanes which have visited the windward islands of the Antilles; while in the two Cuba storms, which have been considered, the northeasterly progression has been found commencing in the northwesterly portion of the Caribean sea. A like course with the latter, I find was pursued also by other hurricanes from the Caribean sea, which have crossed the central portion of Cuba.

A similar course, at least from the north side of Cuba, was taken by that destructive hurricane of the western Atlantic which passed the coast of the United States on the 11th of December, 1844. The hurricane which devastated the western part of Jamaica on the 3d of October, 1780, also pursued a northeasterly course from the Caribean sea, as I had occasion to notice in 1836, and has since been fully shown by Col. Reid, in his work;† and is the most eastward of the storm tracks known to belong to this particular group. Of these storms which have thus crossed the island of Cuba, not one has been traced from the eastern portions of the Caribean sea, and hence there is reason to conclude that they can only have belonged, locally, to the class of storms known under the appellation of Northers, on the western borders of that sea.

Relations of the Cuba Gale to Contiguous Winds and Aerial Currents.—These relations may be viewed, first, in reference to the rotation of the gale, and second, to its geographical progression.

I have already referred to the natural tendency to a left-wise rotation in the winds of the northern hemisphere, when moving on the earth's surface from the equator towards the poles. But it is evident, from the prevalence of violent storms in some regions and their absence from other localities in like latitudes, that this general tendency of rotation does not serve to explain the actual distribution or prevalence of these storms. I have found, however, on a careful examination of marine Journals, that this

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* Derrotero de las Antillas.—American Coast Pilot, &c.

† Lond. Nautical Magazine, v, 203-204. This Journal, xxxi, 120.

tendency to rotation is commonly shown in some degree, in the successive phenomena and phases of the trade winds, in the region near St. Helena and in other tracts of ocean which are exempt from severe storms. In some other regions, as in the western portions of an oceanic basin in the tropical latitudes, the Indian ocean near Mauritius, and in the south Pacific from the Society to the Navigator's Islands, this tendency to a vorticular rotation appears to be directly promoted by local or specific causes, the most efficient of which are found in the actual courses of the several local winds or aërial currents, either in the same plane of the horizon, or at different elevations. Thus, Mr. Thom maintains that the hurricanes of the Indian Ocean are due to the opposite or tangential action of the N. W. and S. E. monsoons on each other in that sea; and I apprehend that the earliest activity and violence of the intertropical hurricanes may often be rightly explained in this manner.*

This, however, cannot always explain the uniformity of the direction of rotation, nor the continued activity of the storms in their progress to other regions and in higher latitudes, where their greatest violence is sometimes developed.† Nor is the extraneous and tangential force of contiguous winds or currents at all necessary to the continued activity of the storm, when once the fall of the barometer and the involute vortical movement has been produced; for the pressure of the external atmosphere, around the basin of the storm, constantly aids or impels the involute movement at the earth's surface, and may be sufficient to maintain the existing vortical action, as may be seen in the case of a common vortex or whirlwind.

We have seen that the two Cuba storms, as well as the Mexican Northers, have appeared to come from the contiguous border of the Pacific ocean. Now, are there any peculiarities in the winds and aerial currents of those regions which may serve to induce or support a leftwise rotation in extensive portions of the lower atmosphere, while moving on or near the earth's surface? I apprehend there are such peculiarities, which have an extensive, constant and powerful influence.

* In such cases I suppose that extensive portions of these different or opposite winds may coalesce in a vast gyration; instead of pursuing their usually independent courses, stratiformly, without interference with each other.

† As in the case of the extremely violent hurricane near lat. 50° in the eastern Atlantic, December 12th, 1844.

First, we find on the eastern portion of the Pacific from Upper California to near the Bay of Panama, an almost constant prevalence of northwesterly and westerly winds at the earth's surface. Next we have an equally constant wind from the southern and southwestern quarter which, having swept the western coast of South America, *extends across the equator to the vicinity of Panama*, thus meeting, and commonly oversliding the above mentioned westerly winds and tending to a deflection or rotation of the same from right to left, ↺. As this influence may thus become extended to the Caribean or Honduras sea, we have next the upper or S. E. trade of this sea, which is here frequently a surface wind, and must tend to aid and quicken the gyrative movement, ↺ ascribed to the two previous winds; and lastly, we have the N. E. or lower trade from the tropic, which coinciding with the northern front of the gyration, ↺, serves still further to promote the revolving movement which may thus result from the partial coalescence of these great winds of Central America and the contiguous seas.

Thus, while a great storm is in part on the Pacific ocean, its N. E. wind may be felt in great force on that side of the continent, through the great gorges or depressions near the bays of Papagayo or Tehuantepec, as noticed by Humboldt, Capt. Basil Hall and others, the elevations which there separate the two seas being but inconsiderable; and when the gyration is once perfected, the whole mass will gradually assume the movement of the predominant current, which is generally the higher one, and will move off with it integrally; as we see in the cases of the vortices which are successively formed in particular portions of a stream, where subject to disturbing influences. It is true that different winds which are found moving direct or obliquely towards each other in the aërial ocean, are never found to *meet*, in the opposing or antagonistic sense, any more than currents of the aqueous ocean; but they either stratify one upon the other when arriving on the same field, or else blend in a partial or common gyration and a united progression of their masses.

There seems, then, to be sufficient cause why the prevailing winds of southern Mexico and Central America should assume an aggregated and sinistrorsal rotation, such as is successively exhibited in the Northers and Atlantic storms;—why the Norther originated in the dry wind of the Pacific coast, should on first reaching the S. W. border of the Gulf of Mexico at Vera Cruz, be found to afford little or no rain;—and why these North American storms should be distinguished for their almost regular *periodicity* of occurrence.*

Progress of Storms due to Prevailing Currents.—That the progression of these and other storms is caused by the predominating current in which they are imbedded, appears nearly a self-evident proposition; and there is much evidence of the prevalence of aërial currents which correspond to the courses pursued by the several storms.

At the windward islands of the Antilles, we have seen that the course of the *lowest* trade winds is often from E. to S. E.; although, from thence to the northern border of the trades, it comes, most commonly, from the N. E. quarter. Mr. Lawson has shown us that at Barbadoes, during a part of the year, the predominating course of the wind, both at the surface and in the region of clouds, is from east to southeast, and this is also the prevailing course of the higher portion of these winds in other months.† His observations, which are confirmed by others, may be deemed to show the actual course which is there pursued by the great body of the trade wind, and thus may fully account for the west-northwesterly course which is commonly pursued by the hurricanes of the Antilles, while passing to the extra-tropical latitudes. In the United States and north of the tropic in the Atlantic, the predominating currents come from the southwest quarter, which also corresponds to the courses here pursued by the great storms.—I have now to maintain that this prevailing southwest current exists far back in the intertropical latitudes, where it is derived, not from the trade wind of the Atlantic, north of the equator, but, to a large extent, from the prevailing winds of the Pacific ocean.

In the lower latitudes a general current from the southwest quarter has been noticed, as seen in the common course of the higher clouds, which pertain to the lower half of the atmosphere;

* The interval between the great Cuba gale and the next stormy weather was the same at both Campeche and New York. I have long since referred to the tendency or approximation to weekly periods which is shown in the occurrence of our storms; a fact which is very generally noticed when they occur on Sundays. At some seasons they are often bi-weekly. From the nature of the case, this periodicity is not absolute, but variable.

† *Ante*, vol. i, 2d Ser., p. 13, foot note.

while immediately below this current the upper portion of the trade wind is found to be from the southeast, as above noticed, and no longer moves towards the equator, but becomes also in due course of its progression to the higher latitudes, a southwesterly wind. This higher and main current from the southwest, coincides with the observed course of the two Cuba storms in the lower latitudes; and in its further progress and periodical variations it also accords with the general course of the storms which have been traced in the temperate latitudes.

That this predominant current is mainly or largely due to the prevailing winds of the Pacific Ocean, I cannot doubt. The great extent of northwesterly and westerly winds found on the eastern border of the Pacific, *in the trade wind latitudes*, has been noticed above, and a portion of this current appears to find its way to the southern parts of the Caribean sea as a surface wind, at certain seasons. Without inquiring whether the higher portions of this current of the north Pacific may not unite with the westerly winds of the Atlantic basin, it may suffice to state, that on the southern coast of Central America it is not found within six or eight degrees of the equator. On the contrary, we here meet with the vast stream of southwesterly winds, which have crossed the equator from the southern hemisphere, where they constantly prevail, as the southerly winds, on the coasts of Chili and Peru. That the lowest and most westward portions of this current are deflected in the southern hemisphere and merged with the southeast trade wind, I do not doubt; but the main current still pursues its course, which is necessarily more towards the northeast on crossing the equator, and in its further progress, as above stated, it is found superimposed on the westerly and other inferior winds of Central America and southern Mexico, and constitutes the main southwest current which is so often recognized in the lower latitudes.

There are two other extensive winds of the Pacific, of a character somewhat anomalous, which in their ultimate tendencies may serve to promote and strengthen this aerial movement to the north Atlantic basin; first, the great westerly monsoon, south of the equator, which, even as a surface wind, is found to cross the greater part of the Pacific, from the Indian Seas, in the principal season of the Northers; and, second, the equatorial belt of westerly winds, which is so remarkable a feature in the aërology of that great ocean.

The course of the great aërial stream into the Atlantic basin, after crossing the equator from the southern hemisphere, is seen from other evidence than the reported courses of the clouds, and occasional surface winds. We learn from Humboldt, that in the great eruption of Jorullo, a volcano of southern Mexico, which is 2100 feet above the sea in lat. 18° 45′, lon. 101° 30′, the roofs of the houses in Queretaro, more than 150 miles N., 37° E. from the volcano, were covered with the volcanic dust. In January, 1835, an eruption took place in the volcano of Cosiguina, on the Pacific coast of Central America, in lat. 13° N., and having an elevation of 3800 feet, the ashes from which fell on the island of Jamiaca, distant 730 miles N. 60° E. from the volcano. The elevated currents by which volcanic ashes are thus transported, are seldom or never of a transient or fortuitous character, and these results therefore afford us one of the best indications of their general course. Thus the progress of the higher portion of the trade wind was marked by the eruption of Tuxtla, lat. 18° 30′, lon. 95°, which covered the houses in Vera Cruz with ashes, at the distance of 80 miles, N. 55° W. and also at Peroté, 160 miles N. 60° W. The ashes from the volcano at St. Vincent, which fell at Barbadoes and east of that island in 1812, mark the course of a current from the westward, which appears there at times, in the region of clouds, and may perhaps be connected with the permanent winds on the Pacific coast of Mexico. Few facts in meteorology are more worthy of our attention than the stratiform character and the vast horizontal extension of the aerial currents, in different portions of the globe.*

Over the United States and the temperate latitudes of the Atlantic the course of this great southwest current is strongly marked both by the movements of the clouds and the general course of the surface winds, notwithstanding the degree of obscurity which is induced by the generally revolving character of the lower winds; for even the northeasterly and northwesterly winds are found comprised in a general movement of the lower atmosphere towards the northeast.† Thus, we find the great Cuba

* For the positions of the volcanoes of Cosiguina and Jorullo and course of the drift, see Charts I and IV.

† For results of seven years' observations on the courses of the clouds and the lower winds, at New York, see this Journal, i Ser., xxxiv, 373; and xxxviii, 323, 324.

hurricane moving in this direction, with a progress of 500 to 1000 miles per day, overlaid and accompanied by a regular southwest current; and yet, if we should attempt to resolve the aggregate course and progression of this storm solely by a general mean of its observed winds, at the earth's surface, we might be led to very erroneous conclusions. For these rotary winds, instead of showing the true progression of the storm, might appear nearly to balance each other. Moreover, the winds of this storm, when considered locally, are found to exhibit nearly the same phases or succession of changes which are common to the temperate latitudes of the north Atlantic basin; which serves to show that our successively observed winds are commonly of a rotary character, and that the common method of estimating the mean resultant courses or progression of the surface winds is necessarily defective and cannot show the true progression of the lower atmosphere.

Some writers have described our northerly winds as sweeping from Canada to the Gulf of Mexico and Cuba, and thus reducing the temperature of the latter regions. But it is evident that these persons have mistaken the cold winds which are found on the western side of our revolving storms, as being a direct current from the higher to the lower latitudes. I cannot find that the above geographical course has ever been pursued by the winds of this continent. On the contrary, in times of the greatest depression of the thermometer, in numerous instances, the cold period has been found to have first taken effect in or near the tropical latitudes and Gulf of Mexico; and has thence been propagated towards the eastern portions of the United States, in a manner corresponding to the observed progression of the storms.

The only proper current of surface winds found coursing towards the equator, in the temperate latitudes of North America, exists on the western side of the continent. But a high current from the northwest, which may have crossed the Rocky Mountains in its course, appears at successive and alternate periods, of considerable duration, in the higher region of clouds. Its direction nearly coincides with the closing winds of our revolving storms, and in the winter season, in some cases, it probably subsides to the surface and immediately follows these storms, for two or three days, and sometimes longer. This will accord with views which have been expressed by the late President Dwight and other writers. But I have in no case found the integral progression of a great storm to be in accordance with the specific direction of this wind.

To my own apprehension, it is the constant course of the lower winds towards the equator, on the western shores of America, below the latitude of 40°, that best explains the aridity of those regions. And it is to a *counter* course of progression, in the lower atmosphere, that the United States, China, and western Europe are mainly indebted for their rains and fertility. To these general and remote causes may also be ascribed the varied electrical and hygrometric phenomena of these different regions.

In closing these imperfect remarks and statements on the American tempests, I tender my thanks to all who have aided me in the inquiry. To Col. Reid, Governor of Bermuda, and through him to Vice Admiral Sir Charles Adam, and other officers of the British Navy, and to the officers and agents of the R. M. steamships, I am indebted for valuable logs of various vessels. Surgeon General Lawson, under the favor of the War Department, has kindly furnished me with the meteorological reports from our military stations, and by the aid of Lieut. M. F. Maury and the favor of the Navy Department I have obtained the logs of our national vessels. Prof. J. R. Beck, secretary of the Board of Regents, has given me free access to detailed reports from the several academies in the state of New York, and various professors and other gentlemen have furnished me with copies of their private journals. I am indebted, also, to many merchants, shipmasters, and others, for important aid, and can only hope that the results attained may prove useful to those who may be engaged in commercial and other pursuits.

Practical Deductions.—It was my purpose to add some further practical exposition of the law of rotation and progression in storms, which might aid the mariner in avoiding their destructive violence, and render the rotary winds and gales more subservient to navigation; but my proposed limits have already been exceeded. It is necessary, however, that the character and general extent of the rotation, and the usual courses of progression, be once clearly understood. Perhaps no one case can better illustrate these conditions than the Cuba hurricane, viewed in its successive positions and local changes of wind, as shown in Charts IV to X, and compared, also, with the varying courses of progression which are shown in Chart I. Let the mariner suppose himself in any position which may fall under the approaching gale as there delineated, and he may perceive the successive changes of wind which must necessarily take place, as the gale passes onward. This gale, in its various local phases, may be taken as illustrating pretty fairly, nearly all the great storms in the northern temperate latitudes, as well as the successive local changes of a large portion of the common winds of these latitudes.

The chief difficulty, in some latitudes, may be in determining the actual course of the gale's progression; for the choice of any course for avoiding the heart of the gale must depend partly on this knowledge. But the local position and latitude of the ship, together with the attending appearances of the storm, will commonly afford sufficient indications.

But a course for avoiding the heart of the storm is not all that is to be considered; for this may be controlled by imperious circumstances or considerations, and little choice be allowed. Other things being equal, it is important, in the commencement of a gale, to take such a course as will be favorable to the ultimate prosecution of the voyage, and will enable the ship to encounter with most safety that portion of the gale which may be chosen, or found unavoidable. This may involve the questions of *scudding* and of *lying to*, which must partly depend on the character and lading of the vessel; and also the *tack* to be preferred, in the latter alternative. The early direction of the storm-wind and the course taken by the ship, will usually decide the further changes of the gale, and it will be proper to lay on that tack in which the ship's head will come up to the sea, as the wind veers or changes,—not that on which she will be headed off by the wind into the trough of the sea, and perhaps taken aback in the heart of the gale. A glance at the storm figures on the Charts will commonly show which tack should be chosen, in different parts of the storm, by vessels bound in different directions. The chief difficulty in deciding is when the ship happens to be on or near the axis of the gale; in which case the discretion of the mariner must rule; but it is desirable first to get away from this line as far as possible. The *degree* of caution and forethought which it may be proper to exercise, may best be determined by the indications of the barometer, not neglecting other appearances.

Thus when vessels are bound westward, in the temperate latitudes, and have southeasterly winds with a falling barometer, they should steer to the northward and westward, instead of keeping their direct course ; and when the wind has veered to the northeast quarter they may resume their true course, with a fair wind which will veer northward ; but if finally compelled to heave to with the wind northeasterly or northerly, they should then take the *port tack*, so as to come up to the wind, in its further changes. This curved course will be found to favor a speedy passage, in most cases, as it gives a fair wind of longer continuance, by placing the ship in the left side of the storm path, and in a position which renders the subsequent northwesterly wind more available. But in case of a gale's hauling *southward* and westward, the ship, when headed off from her course, should be hove to on the *starboard* tack, being in the right hand side of the storm path. The ship will then come up to the sea, as the wind veers by the west towards the northwest.

It will at once be seen that in revolving winds a direct course is not always most conducive to a quick passage, but such variable course should be preferred as will render available the succeeding changes of the wind ; which changes, whether by *south* or *north*, sometimes depend on the course of the vessel.*

The foregoing statements and suggestions are equally applicable in the southern hemisphere, with only this difference ; viz., that in the actual courses of the winds and storms, *south* is there always substituted for north ; east and west remaining the same. Hence, the practice must be varied accordingly.

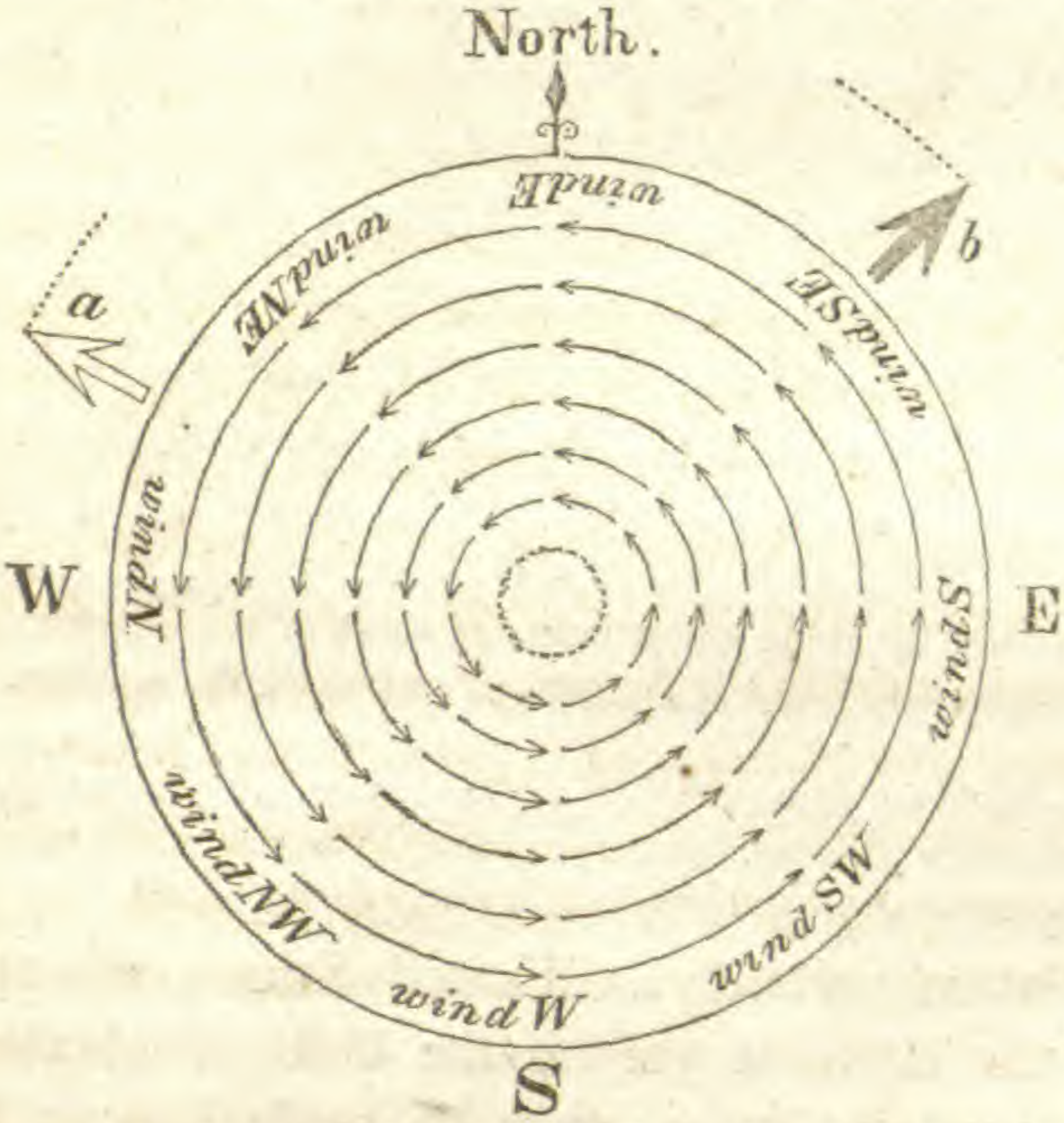
These practical deductions accord with the statements and diagrams which I have published in 1831 and subsequent years. Storm figures of this kind, better elaborated, have also been given by Col. Reid, in his work, accompanied with remarks on lying to, and by him and Mr. Piddington have been placed on cards, and on plates of horn or glass, in order that a mariner may determine the place of a vessel in a storm, by placing the figure on the face of his chart, in such manner as to coincide, on the outer

* See, also, Col. Reid's valuable Note on Progressive Revolving Winds and the Advantages of Sailing on Curved Courses ; Jameson's Ed. New Phil. Journal for July, 1846. Also, Remarks on Lying to, in the Messrs. Blunt's forthcoming edition of the Young Seaman's Sheet Anchor.

circle, with the observed direction of the storm-wind, at the first freshening or commencement of the gale. In this manner the geographical position and coming changes of the storm may be apprehended by those who may not fully comprehend the law of the wind's rotation.*

These storm figures and their uses, may be exemplified in the annexed diagrams.†

Fig. 6.—Storm Figure for Northern Hemisphere.



a, General Course of the Storm in the low latitudes; changing successively to *b*, which is the general course in the Temperate latitudes.

Directions.—First, mark the position of the ship on the Chart, at the beginning of a gale, and then place this figure to the southward of such position, with the needle pointing to the North, and in such location on the Chart that one of the wind arrows in the outer circle will conform to the actual direction of the wind. This will show nearly the true position of the storm at that time. Then move forward the figure in the direction in which gales commonly advance in that latitude and locality, but without turning the figure. The arrows which are thus brought in succession over the ship's place, will show the changes of wind which may be expected, in the further progress of the gale; and also, into what portion of the storm the vessel will be likely to fall, in her then position, and what changes of the ship's course will be likely to favor her safety and the further prosecution of the voyage.

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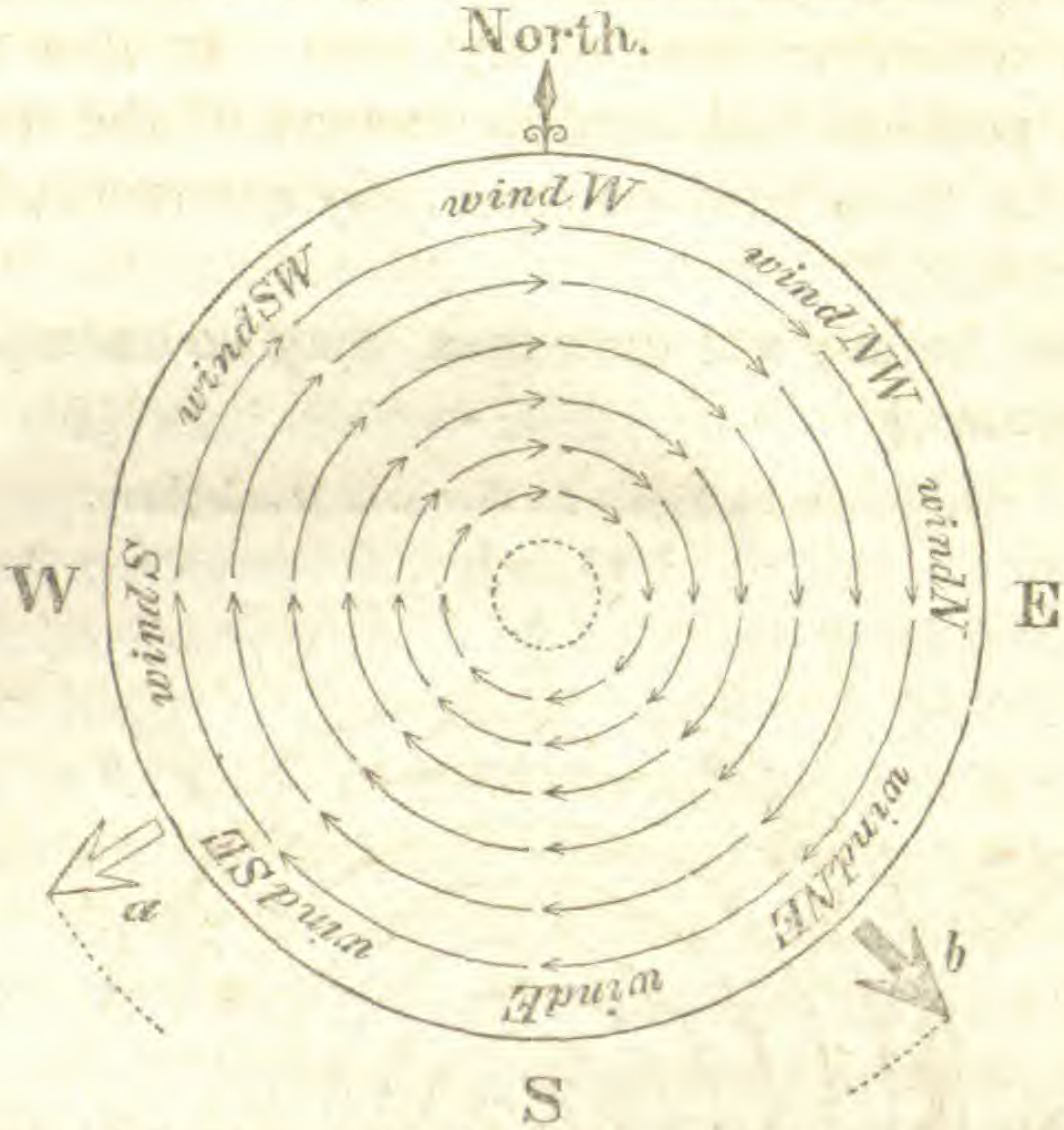
* See Col. Reid's work, first edition, pp. 5—7 and 424—427. Weale, London, 1838. Also, Horn Book of Storms, for the Indian and China Seas, by Henry Piddington: Ostell & Lepage, Calcutta; W. H. Allen, London, 1845. I have lately received from Mr. Piddington his Thirteenth Memoir, which relates to the hurricane of the *Charles Heddle,* before mentioned, and is well worthy of the attention of both navigators and meteorologists.

† See, also, Bowditch's Navigator, edition of 1839, pp. 441, 442; edition of 1845, pp. 440, 441.

Fig. 7.—For the Southern Hemisphere.



a, General Course of the storm in low latitudes, south of the Equator; changing, on its approach to the tropic, to *b*, which is the general course in the southern Temperate latitudes.

Directions.—Place the figure or storm card as before, with the needle pointing to the north, and follow out the directions as before given. The size of the storm figure, for use, may be drawn to the common proportions of a storm on the Chart.

In the Atlantic ports of the United States, the approach of a gale, when the storm is yet on the Gulf of Mexico, or in the southern or western states, may be made known by means of the electric telegraph; which, probably, will soon extend from Maine to the Mississippi. This will enable the merchant to avoid exposing his vessel to a furious gale soon after leaving her port. By awaiting the arrival of a storm and promptly putting to sea with its closing winds, a good offing and rapid progress will be secured by the voyager.

However useful the knowledge of storms may prove, no one will expect the tempest to be disarmed of its power. Nor can disasters in navigation be in all cases avoided. But, contemplating this subject in its relations to the thousands of lives and the millions of property which are lost by shipwreck, almost annually, we cannot doubt that much of this loss might be prevented, by the exercise of timely and intelligent precaution. Indeed, the practical value of accurate knowledge and investigation, in all branches of science, is generally admitted; and in so important a matter as that of the rotation and progression of storms, it will not be estimated too highly.

New York, Sept. 2d, 1846.

ART. XXX.—*On the Volcanoes of the Moon*; by JAMES D. DANA.

(Read before the Assoc. of Amer. Geologists and Naturalists, Sept., 1846.)

THE surface of the moon affords a most interesting subject for the study of the geologist. Though at a distance of many thousand miles, the telescope exhibits to us its structure with wonderful distinctness; and already, as a learned astronomer has observed, we are better acquainted with the actual heights of its mountains, than with those of our own planet.* Having an atmosphere of extreme rarity† (if any) and never obscured by clouds, its features are wholly open to view, and the eye aided with glasses, may wander over its rugged crags, survey its craters, its Alps and its Apennines, from their bases to their summits. Neither are there any sedimentary deposits, soil or vegetation,—for there can be none without water,—and the igneous surface therefore is still its own naked self, exhibiting the results of ig-

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* M. Arago, Annuaire des Longitudes, pour l'an 1842, 2d ed., Paris, 1842.—P. 526, in an article on the Lunar Volcanoes, Arago says:—"Il est remarquable que grace au zèle et à l'exactitude d'Hevelius on ait connu la hauteur des montagnes de la Lune beaucoup plus tôt que la hauteur des montagnes de la Terre."

† The evidence in favor of the existence of an atmosphere and of water in the moon, hitherto obtained, has not been deemed satisfactory. Herschel, at an eclipse, Sept. 5, 1793, observed the sharp horn of the limb of the moon, and says that it seemed perfectly regular; and that a deviation of a single second by the refraction of the solar light in the moon's atmosphere would not have escaped him. *Phil. Trans.*, 1794, p. 39.—As stated in Beer and Mädler, (p. 133,) Schröter calculated the density of the supposed atmosphere to be one twenty-eighth the density of our own atmosphere; and Melanderhjelm demonstrated that the moon's atmosphere, judging from that of the earth, should have one thirty-sixth the density of our own atmosphere. But the above mentioned authors say that we have yet to prove that the moon has any atmosphere, adding that it must be very much more rare than the rarest gas on earth. They observe also that supposing our atmosphere to extend through space, its density half way to the moon, according to the Mariottian law of decrease, would be expressed by the fraction $\frac{1}{100000\ldots}$, the denominator extending to ten thousand zeros. The singular observation occasionally made, that during the passage of the moon over a star, the star appears visible in front of the edge of the moon, before disappearing, may possibly indicate an extremely low atmosphere or surface vapors: but it has been attributed with much appearance of reason (Rep. Brit. Assoc., 1845, p. 5) to diffraction.

The absence of any bodies of water on the moon is placed beyond doubt, both by actual telescopic examination and by inference from the absence of clouds. There are no streams, lakes or seas. An eminent astronomer has remarked that the heat of the surface exposed to the sun would occasion a transfer of any water the moon might contain to its dark side, and that there may be frosts in this part, and perhaps running water near the margin of the illumined portion. But in such a case, would not clouds appear about the margin at times in telescopic views?

neous action in their simple grandeur, unaltered and uncomplicated by any attending operations. We may hope therefore to find some profit in contemplating for a few moments this land of the skies: and although we may not look for very speedy "annexation," we may possibly gather some facts and ideas which the decree of Truth will annex to the domain of Science.

The moon, as we all know, has been minutely studied in a physical point of view, and already some important geological conclusions have been drawn from the facts it presents. The altitudes of its mountains were first estimated by Galileo,* and afterwards were mathematically calculated by Hevelius† and Riccioli. Sir Wm. Herschel continued the investigations, and reported the probable activity of three of its volcanic mountains.‡ Mayer, Huth, Harding, and Schröter,§ and more lately Gruithuisen and W. G. Lohrmann,‖ are other prominent names among those who have added largely to our knowledge of the moon's surface. More recently still, MM. Beer and Mädler have pursued this science of Selenography with wonderful perseverance and labor, and have given corrected results of all previous calculations, with magnificent maps of the moon's topography.¶ 1095 heights were carefully measured by them, and their features, to a great degree of accuracy, ascertained. These maps have afforded M. Elie de Beaumont some deductions alledged as supporting certain geological theories. James Nasmyth, Esq., in the Transactions of the Royal Astronomical Society for the present

* In the article referred to in the Annuaire des Longitudes, (p. 522,) Arago states that Clearchus, on the authority of Plutarch, described the moon as smooth and lustrous like a mirror. Democritus attributed the spots to inequalities of surface. Galileo first observed the lunar mountains with his telescope in 1610, and estimated their height at one twentieth of the diameter, giving 8800 metres for their altitude, which but little exceeds their actual height.

† J. Hevelius, Selenographia; fol., Gedani, 1647.

‡ *Phil. Trans. for* 1780, p. 507, Astronomical Observations relating to the Moon: —*for* 1787, p. 229, An Account of Three Volcanoes in the Moon:—*for* 1794, p. 39, Account of some particulars observed during the late Eclipse (in 1793) of the Sun.

§ J. H. Schröter, Selenotopographische Fragmente zur genauern Kenntniss der Mondfläche ihrer erlittenen Veränderungen und Atmosphäre; 2 vols, 4to, Göttingen, 1791 and 1802.—Gruithuisen, in Bode's *Astrôn. Jahrb.*, 1825.

‖ Topographie der sichtbaren Mondoberfläche, von W. G. Lohrmann; 4to, Dresden und Leipzig, 1824.

¶ Allgemeine vergleichende Selenographie; mit besonderer Beziehung auf die von den Verfassern herausgegebene Mappa selenographica, von W. Beer und Dr. J. G. Mädler; Berlin, 1837.

year, has published important observations on the features of the moon's mountains, and traced out their volcanic character.* A very valuable memoir on the same topics has been presented within the current year to the Institute at Paris, by M. Rozet, in which the moon is shown to have been a globe in complete fusion, which has slowly cooled; and its peculiarities are dwelt upon as an exhibition, in many respects, of the former state of our own planet.†

In all the geological observations which have been hitherto made with regard to the moon, one important feature remains unsatisfactorily explained. I refer to the vast magnitude of its craters. It is not surprising that in view of their stupendous size, many should have been incredulous as to their crater character, and preferred to designate them by some non-committal term, as circular ridges, or ring-mountains; nor that geologists in general have hardly ventured to acknowledge their belief in these lunar wonders. Imagine if possible, in place of an ordinary crater, circular areas 50 to 150 miles in diameter, and 10,000 to 20,000 feet in depth. Such are many of the lunar craters; and they are crowded in great numbers over the larger part of its surface, varying from even a more capacious magnitude, down to those that measure but a few miles in breadth. It is not astonishing that there should be found much difficulty in reconciling their features with those of Vesuvius and Etna, hitherto received too generally as the types of volcanoes and volcanic action. The crater of Kilauea in the Hawaiian Islands is of a wholly different character, and I propose to present some illustrations which it affords, appealing to such general facts regarding it as are already well known. If I mistake not, it will be found to give a full interpretation of whatever has been considered mysterious in these lunar ring-mountains. After these illustrations, we may return again to earth, and apply the knowledge which we have derived abroad, in exemplifying the former geological history of our own planet.

We may first consider the general features of the moon's surface.

About two-thirds of the lunar hemisphere in view, comprising almost the whole of the southern half and the northeast quarter,

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* *Memoirs of the Royal Astronomical Society*, vol. xv, 1846: On the Telescopic Appearance of the Moon, by James Nasmyth, Esq., p. 147.

† Sur la Sélénologie, by M. Rozet, *Comptes Rendus*, 1846, xxii, 470.

are covered thickly with volcanic mountains. Over a large part of the northwest quarter, there is only here and there an elevation, and this comparative nudity extends a considerable distance southward across the equator.

The features of the surface may be distinguished as of five kinds, viz :—

1. The ring-mountains, which are broad truncated cones with immense circular craters. (See the following figures from Beer and Mädler.)

2. Conical mountains, nearly like ordinary volcanoes.

3. Linear or irregular ridges.

4. Large depressed areas, usually termed seas, but not supposed to contain water.

5. Broad pale streaks, of great length.

6. Narrow lines, supposed to be fissures.

Out of the 1095 heights measured by Beer and Mädler, *six* are above 20,000 feet in altitude, and *twenty-two* exceed 15,750 feet.

The broad truncated cones with large circular craters, are its most common elevations, and are among the loftiest. The pits, as we have remarked, are of all dimensions to 150 miles, and of various depths to near 25,000 feet. The crater *Baily* is $149\frac{1}{2}$ statute miles in diameter; *Clavius* is $143\frac{1}{3}$ miles; *Schickard* is 128 miles. 20 to 60 miles is the more common breadth. The depth of *Newton* is 23,833 English feet; of *Casatus* 22,822; of *Calippus* 22,209; of *Tycho* 20,181 feet.* The height above the sur-

* We have stated that Galileo (note to page 336) made the altitude of the higher of the moon's mountains 8800 metres. Hevelius reduced their height to 5200 metres. Riccioli, as M. Arago states, increased Galileo's estimate, and his observations, as calculated by M. Keill, gave for the mountain St. Catherine more than 14,000 metres. Herschel in 1780, (Phil. Trans. for 1780, p. 507; also for 1794, p. 40,) reduced again the heights, concluding from his observations that the loftiest did not exceed *a mile and a half*. The latest investigations have restored them nearly to Galileo's first estimate.

We state, for the information of some who have not paid attention to the subject, that these heights are determined, either from the shadows of the peaks on the central plain of a crater or the exterior surface, or by noting the position of a summit when it first becomes illuminated, and calculating therefrom; the higher the peak, the longer will be the shadow, and also, the sooner its top will be tipped with light. Should it hereafter be established that the moon has an atmosphere, it must be too slight to affect appreciably the altitudes determined: with regard to the breadth of the craters, there can be no more doubt, than with respect to the diameter of the moon itself.

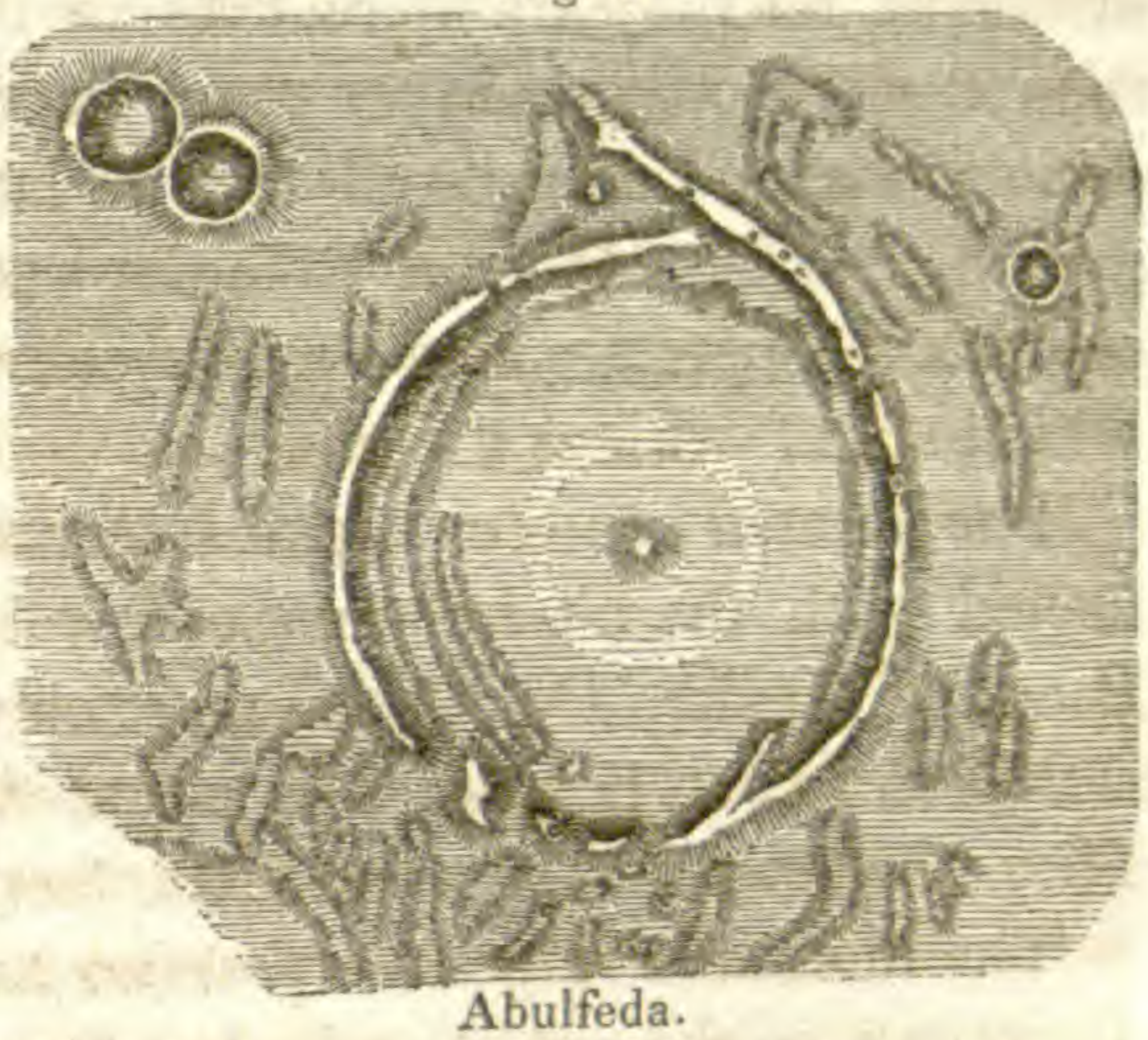
There are many who receive with scepticism the facts we have stated, or even deny where they know nothing. It is taking a high ground, to dispute with all face exterior to the cone, is said by Beer and Mädler to be often but one half or one third the height above the bottom of the crater; the outer slopes are generally steep, so that the margin appears like a raised rim around the pit.

Mr. Nasmyth figures one which is filled to its summit, and is tipped with a plain 40 miles in diameter;* looking, he says, as if "brim full of molten lava," having cooled, probably, when thus filled.

Fig. 1.

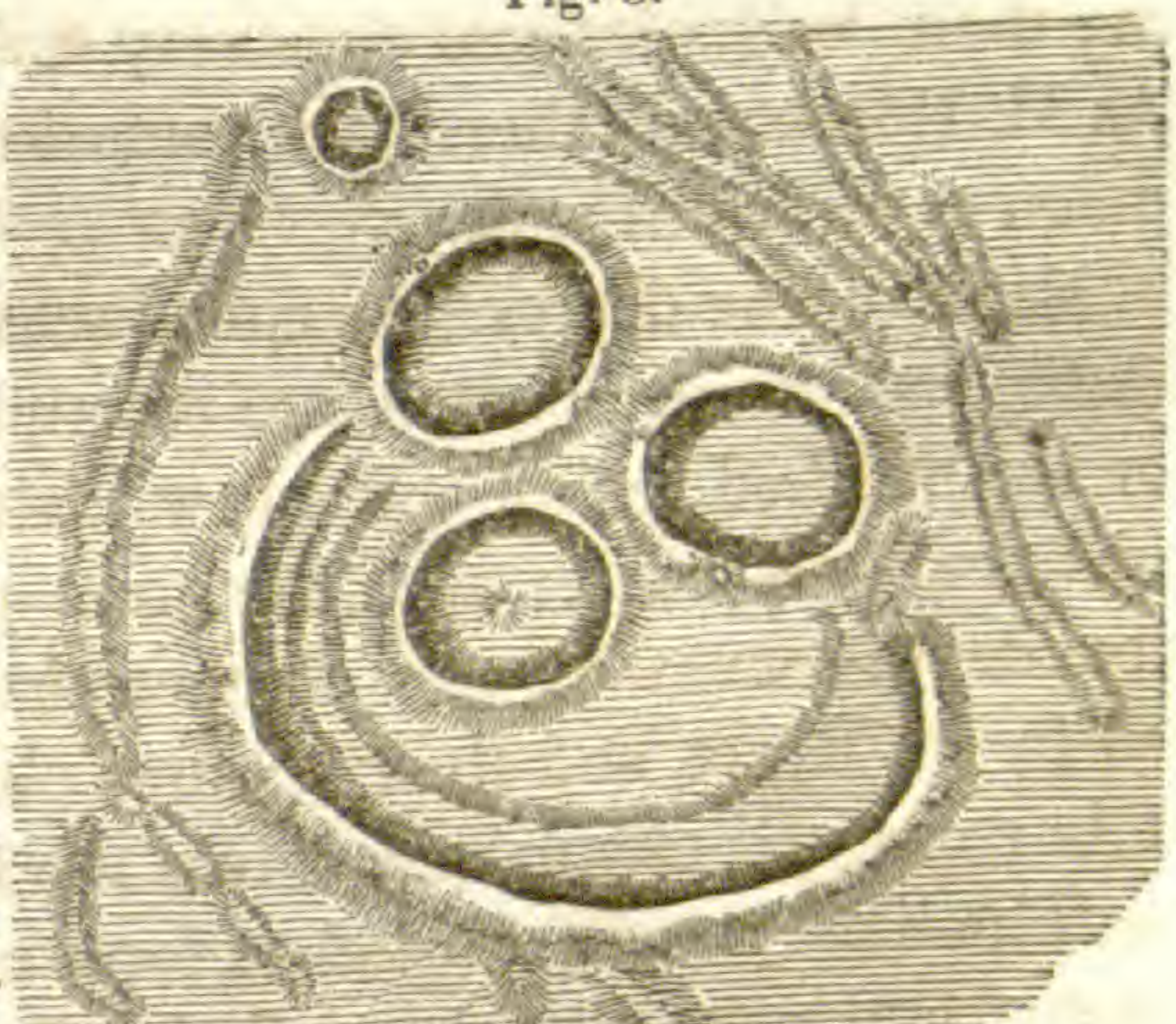
Timocharis.

Fig. 2.



Abulfeda.

Fig. 3.



Heinsius, seen a little obliquely.

The largest craters are not contained in the highest mountains: on the contrary, they are of less altitude than those of medium size, and to a certain extent the height varies inversely with the diameter.

The pits are generally circular, and sometimes almost artificially regular. There are others which consist of two or more coalesced cir-

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the astronomers since Galileo, and one to which ignorance alone would presume. The best antidote we can propose to such presumption, is to take the first opportunity which offers, to look through a good telescope at the moon's surface, and examine its features for themselves. We predict that they will soon become conscious of a growing willingness to be humble learners of such men as Herschel and others who have made the moon their study.

* Mem. of the Roy. Astronom. Soc., xv, 152.

cular pits. In still others, especially the largest, the enclosing walls are broken into a series of ridges, sometimes with large openings like the break of an eruption: yet even then the irregular forms may generally be referred either to a single circle, to a combination of circles, or to the formation of successive ridges one within another. The bottom of the pits though generally flat or nearly so, not unfrequently contains small cones, or ridge-like elevations; we call them small, though some are 5000 feet in height, for they are mere dots in the immense basin. Over the exterior slopes there are many lateral cones of the same *small* dimensions, and occasionally one as large as Etna may be distinguished, besides others of different sizes to a few hundred feet in breadth. There are also circular craters within the larger pits, which are of various dimensions.

The pointed cones or peaks, excepting those immediately connected with the pit-craters, are few in number. According to Beer and Mädler, *Dörfel*, the most elevated lunar peak measured, is 24,945 feet in height; it is situated in the lunar Appenines: *Huygens*, another peak, is 18,209 feet in altitude.

The mountain ridges are peculiar in being generally elongated elevations, or clusters of such elevations, without valleys intersecting their declivities, and thus very unlike the chains of our globe. As M. Rozet and others have remarked, there is no water on the moon to wear out valleys.

Many of the depressions called seas, of which the *Mare Serenitatis*, and *Mare Crisium*, are examples, vary in breadth to five or six hundred miles, and notwithstanding their size, they are identical in character with the great pit-craters, their extent and less depth being their only characteristics. This view is suggested by M. Rozet, and their features clearly sustain it. They contain cones and circular areas like the better defined pits.*

The light streaks alluded to form radiating lines around large cones, and especially about *Euler*, *Kepler*, *Copernicus, and Aristarchus.* They are from one to five hundred miles in length, and cross ridges and depressions, without interruption. They coalesce about the summit of *Kepler*, so that the whole surface appears nebulous.

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* The "seas," according to M. Rozet, have escarpments of 45 degrees, some of which are 400 metres in height. In the interior there are annular cavities, perfect rings in shape, the diameter of which attains sometimes to 100,000 metres.

The various pit craters differ in shade of color, or rather in the degree of light they reflect; and ten different degrees are distinguished in the work of Beer and Mädler. 1 to 3, he says, may be described as gray, 4 to 5 light gray, 6 to 7 white, 8 to 10 shining white. The so-called seas, though but slightly depressed, are sometimes very much lighter than the surrounding surface. In some instances, as these authors state, two pits, side by side, alike in size and features, so differ in brilliancy that one is wholly obscured in the full moon, while the other still shines: the two are seen together again as soon as their shadows reappear. The brightest craters are *Aristarchus*, *Werner* and *Proclus*. *Aristarchus* is 7629 feet in depth. It has a point of greatest brilliancy, besides two or three separate circular spots remarkably light. *Werner* has a single brilliant point. *Proclus* has brilliant walls, yet is dark at bottom.

Sir Wm. Herschel published the first account of existing volcanic action in the moon. In a notice of three lunar volcanoes,* he says that two of them, on April 19, 1787, were either nearly extinct or about to break out, while the third was in actual eruption. April 20, he observed that the active one burned with greater violence; and he estimated that the fiery area was above three miles in diameter. All the adjacent parts of the crater seemed to be illuminated by the eruption.† The other two volcanoes, he says, resembled large pretty faint nebulæ, that are gradually much brighter at the middle, but no well defined luminous spot could be distinguished. Herschel alludes also to an eruption seen by him previously, in 1783.

Such are the general facts, which call for explanation, to wit: the existence of circular pit craters, 5 to 150 miles in diameter, and five to twenty-four thousand feet in depth;—the great number of these pit craters, and their peculiar features;—the depressions of a similar character of still larger area;—and the various degrees of il-

* Phil. Trans. for 1787, p. 229.

† It is supposed that this crater was that called *Aristarchus*, or the *Mons Porphyrites* of Hevelius. *Aristarchus* is described as apparently in action in 1821, by H. Kater, in the Philosophical Transactions for 1821, p. 130; also by Rev. M. Ward, at nearly the same time, in the Memoirs of the Royal Astronomical Society, i, 157; also the following year by Rev. Fearon Fallows, in the Philosophical Transactions for 1822, p. 237. Dr. Olbers observed *Aristarchus* at the same time with Kater in 1821, and attributed the light to the reflection of the earth's light by its smooth rocks.

lumination of the craters. Well may the Vesuvian vulcanist look with doubt upon such vast gulfs; for he finds in his well known volcano, nothing parallel in kind or degree. The little dark hole at the top of his mountain, has scarcely a single point of resemblance to the open walled areas of the moon.

But the case is different with Kilauea, to which we now direct our attention. We observe that the facts this crater presents are precisely the same in kind as those of the moon.

1. The crater is a large open pit, exceeding three miles in its longer diameter, and nearly a thousand feet deep.

2. It has clear bluff walls through a greater part of its circuit, with an inner ledge or plain at their base, raised 340 feet above the bottom.

3. The bottom is a plain of solid lavas, entirely open to day, which may be traversed with safety; over it there are pools of boiling lava in active ebullition, and one is more than a thousand feet in diameter. There are also cones at times from a few yards to two or three thousand feet in diameter, and varying greatly in angle of inclination. The largest of these cones have a circular pit or crater at summit.

Compare these characters severally with the lunar craters, and an identity will be perceived even to the ledge that surrounds the lower pit, and the various forms of the cones. A large number of the lunar craters have an inner circle either as a terrace or ridge. The ledge within *Timocharis* (figure 1) is very similar to that of Kilauea, and is continued around the whole pit unbroken as in the Hawaiian crater. The other figures illustrate the same feature in different conditions. Some of them too contain circular areas with the rim scarcely elevated, (figure 2,) and others raised into cones, (figure 3): and so, in Kilauea, there are at times boiling lakes in the bottom plain, and other pools constitute the summits of cones which they themselves have formed. To appreciate the comparison, it must be remembered that the Hawaiian pit-crater is upwards of three miles in length, and averages nearly half this in breadth; and that the largest boiling pool, though more than a thousand feet in diameter, is still a small spot in the extensive area. During times of greater activity, the whole pit is in every part lighted with the fiery lavas, overflowing at times from the numerous lakes, and jetted from the many cones.

The *circular* or slightly elliptical form of the moon's craters is also exemplified to perfection. For the lakes of Kilauea have this shape; and although the pit itself is oblong, owing to its situation on a fissure, other large though extinct pit craters of Mount Loa are quite as regularly circular in form. Some are twins; that is, are made up of two or three coalescing circles.

We have chosen Kilauea for these illustrations because it is now in action, and the features appealed to have been familiar to us, since the first publications of Admiral Byron, and Rev. Charles S. Stewart. I may add that the facts are finely illustrated in the Narrative of the Exploring Expedition by Capt. Wilkes,* and they will be farther detailed in the Expedition Geological Report on the Hawaiian Islands, now in course of preparation. The exact application of these facts, as far as regards general features, to the *summit* crater of Mt. Loa, will be found fully sustained by the plans and views accompanying the Narrative.

Whence all this close resemblance to the lunar craters, while other volcanoes are so different? It arises from the fact that the action at Kilauea is simply *boiling*, owing to the extreme fluidity of the lavas. The gases or vapors which produce this appearance of active ebullition, escape freely in small bubbles with little commotion, like the jets over boiling water; while at Vesuvius and other like cones they collect in immense bubbles before they accumulate force enough to make their way through; and consequently the lavas in the latter case are ejected with so much violence, that they rise to a height often of many thousand feet and fall around in cinders. This action builds up the pointed mountain, while the simple boiling of Kilauea makes no cinders and no cinder cones. Still, although the lavas of this crater are not thrown to a great height, they may make cones of any angle, even by overflowing alone; especially by small or partial overflowings, which melt together, cooling at the same time rapidly. They thus sometimes raise a steep rim around a pool. This point has been well presented by M. C. Prevost,† and in another place we shall mention many facts in illustration of it.

If the fluidity of lavas, then, is sufficient for this active ebullition, we may have boiling going on over an area of an indefi-

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* See Narrative, Vol. iv, p. 125, and the map of part of Hawaii in Vol. vi.

† Bulletin de la Soc. Geol. de France, xi, 1839 à 1840, p. 183.

nite extent; for the size of a boiling lake can have no limits except such as may arise from a deficiency of heat. The size of the lunar craters is therefore no mystery. Neither is their circular form of difficult explanation; for a boiling pool necessarily, by its own action, extends itself circularly around its centre.* The combination of many circles, and the large sea-like areas are as readily understood.†

With so perfect a correspondence, and so satisfactory explanations by means of an appeal to facts, it is hardly necessary to enter a protest against the ordinary view that these craters are the result of cinder eruptions.‡ We remark only that such eruptions will never take place except from small vents, for the cold which gives the viscidity on which they depend, necessarily contracts the area. In a large pool the fluidity is such that the rising vapors pass off freely: the ejections over its surface, excepting those at the margin, will fall back again into the pool, as in boiling water and Kilauea, and could neither rise to the height nor make such curves as are represented by Mr. Nasmyth. Instead of a large open crater having greater projectile force in proportion to its size, it will actually have far less; and within certain limits the force may be inversely as the diameter, though dependent also on the size of the chimney above.

Any vents in the moon in which the fires had partially subsided, would have densely viscid lavas from partial cooling; and in these there would be loftier ejections like those of ordinary volcanoes, forming high conical peaks with narrow openings, if any, at summit.

The great depth of the lunar pits seems to require another element for its explanation, in addition to what has been presented. This is supplied by the fact of the less specific gravity of substances on the moon; for objects on its surface have but one-sixth the specific gravity they have on the earth: that is, iron would

* Mr. Nasmyth suggests that the quietness of the lunar atmosphere may account for the regularity of the circles.

† M. Rozet observes, in his article referred to, that the moon's craters do not resemble those of our volcanoes: and he explains them by supposing that during the cooling of the moon's surface there were *whirlpools* or circular flowings, which carried the scoria from the centre to the circumference, and thus accumulated the enclosing ridges. We see no cause for the existence of whirlpools; nor for such a result from vortical movements.

‡ See the views and remarks of Mr. J. Nasmyth, *loc. cit.*

weigh but one-sixth what it does here. The lavas would therefore not only be specifically lighter, but would become more blown up with the vapors, or more spongy. On the same ground too, we understand why the moon's great craters should so generally terminate in a raised rim, while those of the earth, like Mount Loa, have very gently sloping sides and summit. This raised rim is fully illustrated about the Kilauea pools, as we have already stated: but in large overflowings, the earth's lavas, owing to their weight, flow far away by gravity, and this feature is therefore never exemplified on the earth on the same grand scale as in the moon.*

We may therefore say unhesitatingly, without fearing an impeachment of our sobriety, that the moon's volcanoes are in fact volcanoes, either extinct or active, although the craters would receive comfortably more than a score of Etnas. We also comprehend the important fact, that a cooling globe would become at first a scene of great boiling lakes from the hardening of some portions;—that on a farther diminution of heat, these lakes would partially cool, excepting points or areas of greatest heat, and thus a subdivision of them would result: or else, they would *gradually* contract their overflowings, and so, as gradually, contract the size of the vent, obliterating all evidence of the former size: or again, they would more *abruptly contract*, and consequently form an inner ledge concentric with the outer walls, and perhaps also other concentric ledges still smaller.

This is well illustrated in the figures, and nothing could better indicate the mode of action which characterizes the moon's craters, for we may trace out the successive diminutions. In *Heinsius*, (figure 3,) which is forty-eight miles in its longer diameter, this is beautifully shown; there is one low ledge within another nearly concentric, and finally a smaller circular pit, of twelve miles breadth,—no mean size, though we call it small. An outer concentric ridge is also apparent through part of its circuit, which may have been a still earlier outline; and being lower than the ridge next within, it illustrates the statement, if the hypothesis be true, that the larger craters have lower walls. It is however possible that it may have resulted from a subsi-

* The elevation theory of Von Buch has been supported from facts in the moon. We offer nothing here on that subject.

dence in the area around, as has happened at Kilauea. The same facts are shown by the mountains *Abulfeda* and *Timocharis;* and we have already remarked that the crater of the last mentioned has very nearly the features of the Kilauea pit. Again they might finally so far diminish their size by the cooling in progress, that there would no longer be free ebullition, and the vapors having to force their way up, would break through with explosive violence, producing an alternation it may be of cinder and lava eruptions, or cinder eruptions alone at summit, and raising up conical pointed peaks. These different phases, in connection with fissure eruptions and upliftings from contraction, from both which causes ridges might result, give us a complete and comprehensive view of the origin of the moon's features.

Are the lunar craters still active? To a very great extent the surface has evidently cooled, and whether there are any active points is a matter of doubt. But without admitting igneous action at the present time in some parts, how can the facts mentioned with regard to the difference in the light of different portions of the moon's surface (p. 341) be satisfactorily explained? This difference may possibly be partly accounted for on the ground, (borne out by Kilauea,) that the bottom of a crater may have a smoother surface than the declivities or plains exterior. Perhaps also there is something attributable to a difference of material, though this is not probable. If these explanations are received as sufficient for the craters, they fail of satisfying us with regard to the light streaks which are so remarkable about some cones—coursing over ridges and depressions without interruption. The fact of illuminated walls to a crater when the bottom is not illuminated, and the general diffusion of light when one or more bright areas of small extent may be distinguished, are also points not easily understood on the above suppositions. May it not be, that we should attribute some of the instances of lighted areas to a covering of vapors from the igneous action beneath? The light streaks are not depressions, and therefore not broad fissures having the great width they exhibit; but they may be *regions* containing many fissures from which vapors are escaping, and by the coalescence of such areas, the summit of a crater like *Euler* might appear illuminated. Such vapors might so cover the bottom of a crater that the walls would appear brightest. Moreover they might leave the cones within a crater still distinct; for if spread out at a height of five hundred feet above the bottom, they would still in many instances be more than ten thousand feet below the summit, and far below too the tops of interior peaks.

As there is little or no water in the moon to aid volcanic action, sulphur has probably played an important part in its igneous changes; for this is not only a prevalent means of igneous operations on our globe, but occurs in meteoric stones, pyrites being one of their common constituents. We may therefore believe that, wherever there is action in the moon, sulphur and any other vaporizable material present, are constantly escaping either as simple vapor or in some gaseous combination, and forming a very low covering over certain portions.

As we have observed, the existence of actual volcanic eruption in the moon is still doubtful, and we must look to new facts to settle the point. But we cannot doubt that the surface in *former* periods has been everywhere in violent action, and that its pools of fire were once measured by scores of miles instead of by hundreds of yards, as with our existing volcanoes. And many of these immense basins remain still open for examination, presenting indications of the various changes which accompanied the gradual decrease of igneous action during the cooling in progress. A map of the moon, if there is any truth in these views, should be in every geological lecture room; for no where can we have a more complete or more magnificent illustration of volcanic operations. Our own sublimest volcanoes would rank among the smaller lunar eminences; and our Etnas are but spitting furnaces.

In continuation, I would ask attention to some thoughts bearing on our own planet, which are suggested by this study of the moon's surface.

I. If the earth was once a melted globe, it must have passed through the same phases as the moon, with this *very important difference*, that the whole surface during its progress was subject to the denuding action of waters, and from the first had valleys and sedimentary rocks in progress. It must have had originally its boiling pools of vast extent; which as the action decreased in violence would more or less gradually contract. Are there any remains of these great craters? Or have they disappeared by a decrease in the volcanic action and thus graduated into existing mountains, or have they been swept away by the changes of time? M. von Buch has described a circular area on the island of Palma, one of the Canaries,* six miles in diameter, which has been compared to a lunar crater, with some appearance of reason. It is in fact hardly twice the diameter of Kilauea, which it otherwise resembles. On Mauritius there is a similar area fifteen miles in diameter, surrounded by precipitous walls composed of the edges of strata dipping outward.† Either it is a volcanic mountain whose centre has fallen in, as suggested by M. Bailly, or it is the remains of a great pit-crater. I merely state the fact without expressing an opinion. Other instances might be mentioned, but this will suffice. At the present period, few active boiling pits remain, and Kilauea is the only one whose characters have been well determined. The surface fires of the globe have so far subsided in action, that in nearly every existing volcano, cinder-ejections characterize the action at summit, and eruptions of lavas in streams are confined to fissures through the sides and flanks of the mountain.

II. We are led by the facts displayed, to remark also on the *origin of the mineral constitution of igneous rocks.*

It has been a difficult problem for solution, why volcanic regions should have a centre of solid feldspathic rocks, unstratified and compact, while the exterior consisted mainly of basaltic lavas. Scrope, Von Buch, and other writers on volcanoes, have mentioned instances of this structure; and it seems to characterize generally the large volcanic mountains. It is well exhibited when the elevations are cut through by gorges; and when not, the clinkstone appears often at the summit of the cone or dome. The explanations we here venture, proceed on two principles:

1. *The motion which belongs to a boiling fluid.*
2. *The less fusibility of feldspar than the other ingredients.*

In the great boiling pools, there will necessarily be a rising of the fluid, in the hotter part, and a flow away towards either side, producing a kind of circulation. This is no hypothesis, as the fact may be witnessed in any boiling cauldron; and the lavas of Kilauea are a visible example of it. The ebullition in lavas

* Desc. Phys. des Iles Canaries. Paris, 1836, p. 281.
† Darwin's Volcanic Islands. London, 1844, p. 30.

on the earth, proceeds principally from the vapors of water and sulphur, which are constantly rising through them, inflating them more and more as they ascend, and finally escaping in bubbles at the surface. Now the feldspar being the less fusible part of the lavas, would thicken somewhat, wherever the temperature became too low for complete fusion; the more liquid portion would then ascend most easily, being carried along by the inflating vapors, and much of the feldspar would thus be left behind, and it might be in a nearly pure state. The centre of the volcano under this action, becomes necessarily feldspathic. The summit might therefore eject either basaltic or feldspathic rocks from the material of the vent; though when the action was violent and deep, it would eject feldspathic rocks alone.

At the same time the *basaltic* lavas, descending laterally in this system of circulation along the sides of the great central conduit, may pass out as flank eruptions through fissures. Besides, there will also be basaltic ejections from sources of lavas at a distance from the central conduit, where they have not been subjected to the separating process described; and this may be the more common source.

Mountains with a feldspathic centre, and basaltic layers forming the circumference, are therefore quite intelligible without supposing the feldspar to have been first thrown up, or appealing to a different system of fissures for their origin, and the examples which the moon presents, are more extensive than is necessary to explain the widest facts on the earth.*

In these remarks we have spoken of the lavas as consisting mainly of feldspar and augite, their more common constitution; but we use the terms in a general sense, understanding by feldspar one or another of the feldspar family of minerals, and by

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* It is common to say that certain domes of trachyte were thrown up in a *pasty* or imperfectly fluid state,—in order to account for the fact that there is no appearance of the rock's having flowed in streams. Without intending to refer the origin of these domes to any particular cause, I would suggest the query, whether, if their formation was subaërial, this *pasty* state does not necessarily imply that the ascending vapors would have found some difficulty in escaping, and would have broken through with explosions, as explained in the foregoing pages; and consequently that there would have been scoria and cinders accompanying the ejections? or may we believe it probable, that the paste was so dense that water would not make its way up and escape as vapor? Is this last supposition borne out by any existing example of subaërial volcanic action?

augite the remaining fusible material, whether ordinary augite (silicate of lime, magnesia and iron) or silicates of one or more of these bases or alumina in other combinations.

There is some difficulty in applying this hypothesis to particular cases, on account of our ignorance of the actual fusibilities of the materials of the lava, in the condition in which they are placed; for we know that an infusible mineral may be held in fusion under certain circumstances, or with certain mineral associations, far below the temperature at which it fuses: or, previous to the commencement of cooling it may be in some other combination.

We should infer that the process which separates the feldspar, would also separate any excess of the more infusible mineral quartz. This may not follow: still it is a remarkable fact that the quantity of quartz contained in trachyte is often in great excess, as analyses have shown. But why is not the infusible mineral chrysolite also detained? The fact appears to be, that it is of subsequent formation. The small proportion of silica it contains implies a deficiency of this substance, while, as we have stated, in the feldspathic rocks there is often an excess. It may, therefore, under certain circumstances proceed from the basaltic material, for its elements are the same in different proportions. Subsequent investigations may give us more light on this point.

The general principle which we have above brought forward, is well illustrated in the fact that the scoria or surface glass of any vent, where it occurs, is the most fusible part of the lava, consisting in general of ferruginous or alkaline silicates, and containing no magnesia. On account of the diminished heat, this material alone remains sufficiently fluid to be inflated and borne up to the surface by the rising vapors: and this takes place in spite of superior gravity.

We hence comprehend the *rapid cooling* which characterizes ejected lavas, *for only a part of the material is in complete fusion.*

The actual nature of the *cooled igneous rock* may be more correctly understood, if we consider that the minerals present will depend, not only on heat and pressure and the causes above alluded to, but also on rate of cooling. The effect of slow cooling is exemplified in the feldspathic centre of a volcanic mountain. Being wholly enclosed by rocks, the heat of fusion passes off slowly, and owing to the pressure of its own superincumbent portions, the rock is compact. Whatever augite may be present, instead of appearing as augite, will take the form of hornblende, a mineral which requires slow cooling, and differs from augite in the crystalline form which it thus receives. In corroboration of this statement, hornblende is common in trachytes and such feldspathic rocks. The same remarks apply to mica: and other minerals also may form according to the elements present. Chrysolite is not met with: it occurs only where there is a more rapid rate of cooling, as in the formation of ordinary basaltic rocks or lavas.

Farther we observe that with a still more gradual rate of cooling, the whole feldspathic rock becomes crystalline in texture like a granite or syenite, and it is well known that granite-like or syenitic rocks or peaks occur in some volcanic regions, whose interior has been laid open by denudation. Many minerals too might crystallize under these circumstances, which with more rapid cooling would not be distinguishable.

The boiling process in a large volcano, therefore, in connection with the circumstances of temperature, rate of cooling, the fusibilities of different minerals, and the other causes alluded to, will account for the various features, positions and relations of igneous rocks, and for many facts relating to the distribution of igneous minerals.* We may hence reasonably infer that granite and granite minerals may form under the same circumstances, if the elements are present in the material in fusion; for the syenites alluded to are closely allied rocks in texture and character. At a former meeting of this Association, it was suggested by me that *some* regions of granite peaks may have been centres of ancient igneous action; and their being surrounded or bordered by hornblendic rocks, seems to point to some actual analogy with the trachytic centres and basaltic circumference of mountains admitted to have been volcanic.

The opinion that the nature of the resulting rock is directly connected with the nature of the rock which had entered into fusion, cannot be maintained if the above views be true. On the contrary, it appears that while the result may thus be varied, the

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* The general causes referred to, act under the guiding laws of crystallogeny, which laws regulate the particular positions of minerals according to the principles exemplified in segregations or radiated crystallizations, and the laminated or cleavable structure of igneous rocks.

mode of distributing minerals in a volcanic focus by the boiling process, may produce from the same material, rocks of a predominant feldspathic character in one place, and rocks of a hornblendic or augitic character in other places. Simple feldspathic granites may be fused and ejected as feldspathic rocks, like those of porphyry dikes. But it is an interesting fact, that the rock of most dikes is of the augitic (or hornblendic) kind, like the dikes of volcanoes that rise from sources in which the *separating* process could not have been operating.*

We also arrive at the important conclusion, that rocks perfectly compact in texture may be of subaërial origin, as we have pressure from the fluid lavas themselves in the volcanic focus.

Another deduction proceeds from the facts stated;—that the same igneous rocks may occur of all ages, provided the atmosphere or waters of the earth were not too warm for the more rapid rate of cooling required for uncrystalline rocks. Scorias, basalt, trap, porphyry, syenite, granite, have no relations to one epoch rather than another, beyond what may depend on the circumstance just mentioned. Whenever therefore in the history of the world, the variations in heat, pressure, and rate of cooling, now possible, may have taken place, similar rocks to those of the present day may have been in progress:—and as far as the variations of former times, in these respects, may now take place, former rocks and minerals may still be in progress. In this statement it is implied that the necessary elements are present in the fused material.

III. *Origin of Continents.*—The moon gives us hints on another topic of great interest, relating to the distribution of land and water on our globe. We have mentioned that there is a large area covering nearly one third of the hemisphere facing the earth, which is mostly free from volcanoes, while on other parts the craters are closely crowded together. We may therefore reason-

* Mr. Darwin has accounted for the distribution of feldspathic and augitic rocks in volcanoes, on the ground of their different specific gravity. But with this cause alone, the lower parts of the feldspathic peaks should be expected to contain the heavier augitic material, which is not the case. He also argues that the feldspar would rise in the fluid as crystals, and so the augite sink. But we know in the first place, that crystals do not appear till incipient solidification, and if the augite and feldspar were both in distinct crystals, where would be the fusion? Again, the feldspar rocks are *amorphous*, except with a very slow rate of cooling; and how then can the existence of appreciable crystals be assumed?

ably infer, that over this naked portion, the surface first became solid, and has therefore cooled the longest and to the greatest depth. Consequently, the contraction from cooling, which was going on, would take place most rapidly over the thinner and more yielding volcanic portion; and unless the ejections made up the difference, this part would become somewhat depressed. A melted globe of lead or iron in the same manner, when cooling unequally, becomes depressed by contraction on the side which cools last. Now on our own globe, the continents have to a very great extent been long free from volcanic action. A glance at a map of Asia and America will make this apparent. It is usual to attribute this almost total absence of volcanoes from the interior of the continents to the absence of the sea; but it is fatal to this popular hypothesis, that the same freedom from volcanoes existed in the Silurian period, when these very continents were mostly under salt water, a fact to which the wide spread Silurian rocks of America and Russia testify. Over the *oceans*, on the contrary, all the islands excepting the coral, are igneous—and the coral may rest as we have reason to believe on an igneous base.

It is therefore a just conclusion that the areas of the surface constituting the continents were first free from eruptive fires. These portions cooled first, and consequently the contraction in progress affected most the other parts. The great depressions occupied by the oceans thus began; and for a long period afterward, continued deepening by slow, though it may have been unequal, progress. This may be deemed a mere hypothesis; if so, it is not as groundless as the common assumption that the oceans may have once been dry land, a view often the basis of geological reasoning.

Let us look farther at the facts. Before the depression of the oceanic part of our globe had made much progress, the depth would be too shallow to contain the seas, and consequently the whole land would be under water. Is it not a fact that in the early Silurian epoch nearly every part of the globe was beneath the ocean? So we are taught by the extent of the formations. The depth of water over the continental portions would be very various; but those parts which now abound in the relics of marine life, were probably comparatively shallow, as amount of pressure, light, and dissolved air, are the principal circumstances influencing the distribution of animals in depth, and acted formerly, we may believe, as at the present period. Here then we see reason for what has been considered a most improbable supposition, the existence of an immense area covered in most parts by shallow seas and so fitted for marine life.

If we follow the progress of the land, we find that with each great epoch there has been a retiring of the sea. In the coal deposits we have an abundant land vegetation. Subsequently, the progress on the whole was giving increased extent and height to the land and diminishing the area of the waters. Instead therefore of a bodily lifting of the continents to produce the apparent elevation, it may actually have been a retreating of the waters through the sinking of the ocean's bottom. The process however has not been a continuous one: for during each epoch,—the Silurian and the more recent,—there have been subsidences as well as seeming and actual elevations, and various oscillations of the continental surface, from subaërial to submarine and the reverse. When contraction had once taken place over the continents as well as under the ocean, there may have afterwards been expansions again through the return of heat from some cause. And thus various irregularities have taken place, such as the rocks indicate. In the tertiary period and since, the apparent rise of the land has been still to some extent in progress. And is there any evidence that this could have arisen from a sinking of the ocean's bed? The evidence is undoubted. For Mr. Darwin has shown satisfactorily, (and farther observations to the same end, and to many interesting conclusions, will be presented in the writer's geological report on the Pacific), that a subsidence of some thousands of feet has taken place since the corals commenced their growth. Every coral island is a register of this subsidence.*

And why should not the ocean's bottom subside, as well as the land? What has given the continental portions of our globe their elevation, as compared with other parts, if not the unequal contraction of the whole? Can we safely affirm—in words of high authority—"that the stability of the sea and the mobility of the land are demonstrated truths in geology,"† when mobile land forms also the bed of the ocean, and its changes must affect the

* See Silliman's Journal, xlv, 131, 1843.

† Leonard Horner, Esq., Anniversary Address before the Geological Society of London, January, 1846; Quarterly Jour. of the Geol. Soc., No. 6, p. 199.

stability of the superincumbent waters; I ask, can we safely make this affirmation, until we know something more certain than past investigations have revealed, about the geological history of the two-thirds of the surface of our planet that are concealed beneath its oceans?

In our conclusion from the above reasoning, we fall in nearly with the views presented by a distinguished French geologist, M. C. Prevost, who has argued with much force in favor of subsidence as a cause of the apparent elevation of the land: though it may be right to state that these conclusions were arrived at previously to seeing his memoir.* There appear to be many objections to the opinions of M. Prevost, as they are expressed by him, inasmuch as no allowance is made or admitted for minor disturbances and actual elevations by subterranean forces. His views however are well worthy the attention of the geological enquirer.

The principles explained place the general theory of change of level by contraction upon something better than a hypothetical basis, and are believed to explain the actual causes by which the changes have been produced. They correspond moreover with the view that ruptures, elevations, foldings and contortions of strata have been produced in the course of contraction. The greater subsidence of the oceanic parts would necessarily occasion that lateral pressure required for the rise and various foldings of the Alleganies and like regions.

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* The general theory of changes of level by contraction and expansion, and the rise thus of continents, was first presented by Mr. Babbage and De la Beche. M. C. Prevost takes the different ground that all seeming elevations are the result of subsidence. His propositions are as follows, (Bulletin de la Soc. Geol. de France, xi, 1839 à 1840, p. 186):—

"1. Que le relief de la surface du sol est le résultat de grands affaissements successifs, qui, par contre-coup, et d'une manière secondaire, ont pu occasionner accidentellement des élévations absolues, des *pressions latérales*, des ploiements, des plissements, des ruptures, des tassements, des failles, etc.; mais que rien n'autorise à croire que ces divers accidents ont été produits par une cause agissant *sous le sol*, c'est-à-dire par une force soulevante;

"2. Que les dislocations du sol sont des effets complexes de retrait, de contraction, de plissement et de chute;"

"3. Que les matières ignées (granites, porphyres, trachytes, basaltes, lavas,) loin d'avoir soulevé et rompu le sol pour s'echapper, ont seulement profité des solutions de continuité qui leur ont été offertes par le retrait et les ruptures, pour sortir, *suinter* et s'épancher au-dehors."

ART. XXXI.—*Description of three varieties of Meteoric Iron.* —1. from near Carthage, Smith County, Tennessee; 2. from Jackson County, Tennessee; 3. from near Smithland, Livingston County, Kentucky; by G. TROOST, Prof. in the University of Nashville, Tennessee.

1. *Meteoric Iron from Carthage, Smith County, Tennessee.*

IN vol. xlix, p. 336, of this Journal, I published a description of four varieties of meteoric iron, one of which was of the highest interest as its fall had been witnessed by several persons. My collection has since been augmented by three other newly discovered specimens. A friend of mine, Samuel Morgan of Nashville, learned sometime in 1844 that a large mass of some metal had been found in Smith County near Carthage, Tennessee, which was considered as silver, and a small sample of it was given to him which we both recognized immediately as meteoric iron. Mr. Morgan immediately endeavored to learn its history and to get possession of it; but as I observed above, it being considered a precious metal, he failed, and every thing was enveloped in mystery, till it became known that it was not silver. He learned then that it was in the possession of a blacksmith, that it was found about a mile from Carthage the County seat of Smith County, and Mr. M. obtained it last year for a moderate price. It weighed 280 pounds—an oblong shapeless mass, its surface showing here and there some projecting octahedral crystals. A piece of it was sawed off weighing 39 lbs. which now forms one of the ornaments of my cabinet. This magnificent specimen has a polished surface of about 12 by 9½ inches. None of the metallic meteorites, that I have seen, exhibit such beautiful Widmannstattean figures which have become visible on its polished surface, without the aid of acid. It shows rhomboidal and triangular sections which are generally a full inch, and a few, more than an inch, in length. These figures cover uniformly the whole of the polished surface. No heterogeneous materials are visible in it. There is only one cavity of about ½ inch on its surface.

The unpolished part is partly crystallized and partly amorphous and compact. Some crystals (parts of octahedrons) project for more than an inch above the mass. The iron is very tough and malleable, and, as it contains no traces of pyrites, not susceptible of being acted upon by atmospheric agencies. A partial analysis has convinced me that it contains a notable proportion of nickel; the other components I have not ascertained.

2. *Meteoric Iron from Jackson County, Tennessee.*

I am also indebted to my friend, S. Morgan, for the knowledge of a variety of meteoric iron which is found in Jackson County in this state. Mr. M. received only a sample of it, but its history, quantity and locality are still kept in profound secrecy, as it is yet considered as silver and its owner is looking out for its original deposit. The piece in my possession weighs 15 ounces. It is an accumulation of large crystals, some of an octahedral, others of a tetrahedral form—of a very soft malleable iron. Its bold and solid crystals distinguish it from the other Tennessee meteoric iron.

It was accompanied by some fragments of the crust of meteoric iron weighing $3\frac{1}{8}$ ounces. It is a hydroxide of iron of a brown and yellow color, penetrated here and there with metallic iron and resembles the crust of the Sevier County iron; but the iron itself differs very much from the last named iron. This crust and the bold crystalline structure, shows that the original mass must have been large.

3. *Meteoric Iron from Livingston County, Kentucky.*

Some six or seven years since a piece of metal was handed me with the request that I would see how much silver it contained. When I told the person, who showed it, that it did not contain silver and was only iron, he became displeased and departed without answering my queries as to its locality, quantity, etc. Some years after I received another piece of it from a different person. I convinced him that it was iron, but all the information I could obtain was that an abundance of it was found, and as he intended to purchase the land on which it occurred, he refused to mention the locality but promised to send me a large piece of it. The man did not keep his promise and I have not heard of him since. But some time last year Colonel Player of Nashville mentioned to me that he had the offer of a tract of land on which such iron ore (showing the identical meteoric iron) was found in abundance—he thought it was ore of an excellent quality—that it did not require any preparation and could be worked in the same state it was found in, showing me a cold chisel made of it. I told him to examine the land and see whether an abundance of it really did exist, mentioning at the same time, that I was convinced that but a single, or at least very few pieces of it could be found, because it was meteoric iron, which, so far as is known, falls only in single masses. Colonel Player went to the spot and then learned that only a single piece of it had been found. From this gentleman I learned that the original piece was pretty large but that it had been cut up and worked in the blacksmith shop; that the only piece now existing in its natural state, and which he had in his possession was of about 8 or 10 pounds; part of it, together with the cold chisel mentioned above, is now in my possession.

This piece weighs $4\frac{3}{4}$ pounds. It is a remarkable variety, has a fine granular fracture, similar to that of steel, is very compact, and has no traces of crystals, or of a crystalline structure. It is a shapeless mass and has a rough surface, where it has not been cut—it has the properties of steel; in fact the above mentioned chisel is equal to one made of cast steel. An incomplete analysis has given me 10 per cent. of metal mostly nickel. It was found near Smithland, Livingston County, Kentucky.

Nashville, Aug. 17th, 1846.

Art. XXXII.—*A Sketch of the Geology of Texas;* by Dr. Ferdinand Rœmer. (In a letter to the Editors dated New Braunfels, German settlement on the Guadaloupe, in Western Texas, Comal County, June 12, 1846.)

During the four months which I have already passed in Texas, my time has been employed in the study of its geological relations: and although my knowledge of the country is yet incomplete and mostly confined to the western section of the territory, I may hope that the following sketch of what I have seen, considering the little that is known, will prove of interest to your readers, and afford a basis for further investigations.

It is not a very encouraging fact to the geologist in Texas, that only there, where civilization ceases and the wilderness commences, the geological relations of the country begin to be interesting. The line which separates the settled part of the country from the hunting grounds of the Indians, is almost exactly identical with that which divides the more modern diluvial and alluvial deposits from the secondary formations. The three points, lying in the same straight line, San Antonio di Bexar, New Braunfels, (the German settlement on the Guadaloupe,) and Austin, are alike the extreme frontier parts of Western Texas, and the limit of the cretaceous deposits of the upper country towards the southeast. In the few observations which I have to make, I shall therefore separate the particulars relating to the lower country from those bearing upon the secondary formations in the section of country lying beyond the just mentioned line.

The route by which I reached the northwestern section of the country, leading through Houston, San Felipe, Austin, Columbus on the Colorado, Gonzales and Seguin, is nearly devoid of any geological interest; you see no solid rock in place through the whole distance, excepting irregular layers of a coarse calcareous sandstone of very modern origin, exposed on the steep banks of some of the rivers. The surface is elsewhere a thick diluvium of loose materials consisting either of a fertile vegetable mould, or of rounded pieces of hydrate of iron—as over the barren section between San Felipe and Columbus—or of sand and gravel, as near Gonzales and elsewhere.

The gravel and sand are of some interest on account of the abundance of fossil wood which they contain at many different places. I saw numerous localities of it between San Felipe on the Brazos, and Gonzales, and in the valley of the Colorado between La Grange and Austin. This petrified wood is often found in large pieces, and it is said that occasionally whole trunks of trees are met with, which however I have not myself seen. The fossilization of the wood is generally imperfect, the silex into which it has been turned showing most minutely the original structure. Most of the wood is dicotyledonous; but not having the leisure or the necessary books of reference, I have not made out the species. I have only observed that in some of the wood the fibres are extremely close, and the whole structure very compact, exceeding any tree in the existing flora of Texas.

As the gravel and sand in which most of this fossil wood occurs is generally covered by post oak timber, which alone grows on a soil of such sterility, it is a common belief among the farmers of the country that the fossil wood was derived from similar oak trees of earlier growth in the same region. But this is evidently a mistake, as the fragments bear distinct marks of having been rolled and transported by water; and the question arises as to the geological formation in which this wood was originally deposited and petrified. The gravel where it occurs consists chiefly of rounded pebbles of silex, mostly of a reddish color and of a similar appearance to the silex of the cretaceous formation in the upper country. This might lead to the supposition, that the wood as well as the pebbles derive their origin from cretaceous strata. But it is an objection to this view, that no remains of dicotyledonous plants (the Coniferæ and Cycadeæ excluded) have hitherto been found in strata older than the tertiary deposits, excepting the leaves of *Credneria* in the green sand of Germany; and moreover, the fossil wood becomes scarce as you approach the hilly country where the cretaceous strata are in place. We may hope that the doubt will be removed by an examination of the eastern section of the country, where the fossil wood is said to be still more abundant, and where according to Kennedy,* between the Trinity and Nueces rivers, great numbers of petrified trees lie imbedded in the soil.

The thickness of the diluvial beds diminishes when you approach the cretaceous deposits, and when you are near the abovementioned line the cretaceous strata begin to show themselves in the deep ravines and gullies; but they do not appear at the surface until you pass that line. At the same time the topographical character of the country entirely changes. Instead of the low undulations of the prairies, hills of considerable height with sharply defined outline, and but a short distance beyond, real mountain ranges show themselves to the north, marking the limit between the rolling and mountainous region of Texas.

The place where I first met with a cretaceous deposit was at New Braunfels, exactly where the old Precidio road from San Antonio to Nacogdoches crosses the Guadaloupe. Here in the bed of the river a white limestone is exposed which looks very similar to the "chalk marl" of England, and to the "plänerkalk" of Saxony. It is white, rather compact, in some beds more marly, and occasionally it contains green particles of silicate of iron. The stratification is perfectly horizontal. Some of the

* Texas, Vol. I, p. 119.

strata abound in fossils. The most common species is a small Ostrea, similar to *Ostrea vesicularis*, Lamk., but never growing as large and generally not being more than one inch in diameter. Next to it comes a large species of Exogyra, analogous in form to *Exogyra costata*, Say, but having concentric laminæ instead of the oblique folds of that species. It certainly is the largest species of the genus, as some specimens of it are more than nine inches in length. Equally common with this Exogyra, there are two species of Inoceramus, one of them being similar to the *Inoceramus Cuvieri*, Sowerby, and the other to the *Inoceramus cripsii*, Mantell. The *Pecten quadricostatus*, is also abundant in some beds, a characteristic fossil, widely spread in cretaceous deposits. Of the large family of the Brachiopoda, I saw but a few specimens of *Terebratula gracilis*. The family of the Cephalopoda is not better represented. I saw two species of Ammonite, one of them of the section which the *Ammonites varians* belongs to, and a Nautilus, which certainly is nearly allied to the common *Nautilus simplex*, if not identical with it. In one stratum which is only about five inches thick, sharks' teeth of the genus *Lamna* and other genera abound.

The same limestone ranges very far on both sides of the Guadaloupe, and every where parallel to the chain of high hills or mountains which separate the Indian country from the settled part of Texas. On one side I have followed it as far as Austin on the Colorado. The hills, on the slopes of which this city is so handsomely situated, consist of limestone with the same mineralogical and organic characters as that on the Guadaloupe. Among the fossils I found here a large Ammonite similar to the *Ammonites Rhotomagensis*, Sowerby. Near Austin also a single specimen of the *Exogyra costata*, Say, was met with. It seems that this species among the fossils of the North American cretaceous formation has the widest range. Besides its most abundant occurrence in the cretaceous marl of New Jersey and at some places in the Southern States, it is mentioned by Featherstonhaugh* to be frequent at different localities in the State of Arkansas.

From several facts I have obtained, it is certain that the same limestone extends beyond Austin much farther to the northeast.

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* Excursion into the Slave States, p. 119.

On the other side of the Guadaloupe, the limestone is exposed in many places on the road from New Braunfels to San Antonio, which leads in a southwestern direction. Where the road crosses the Cibolo, the limestone forms in the bed of the river singularly shaped rocks, through which the water has eaten its channel, and which are teeming with fossils. At San Antonio the limestone is opened by several stone quarries, and the far famed Alamo mission has been built of it. West and south of San Antonio, I have not yet seen the limestone myself, but I have reason to believe that it extends much farther in both directions. A specimen of the same Exogyra which abounds on the Guadaloupe, was brought to me and said to have been found among the pebbles in the bed of the Rio Grande.

Besides this white marly limestone, there is another series of strata to be described. Ascending, from New Braunfels, the range of steep hills which stretches to the northwest of this place, as soon as you leave the level of the valley, horizontal strata of a compact yellowish limestone are seen, resembling very much the compact limestone of Italy, and of Southern Europe in general. Some of the strata are very siliceous, containing large compressed nodules of pure dark colored silica. Other beds are so soft that they easily decompose through the action of air. Where limestone is very compact, hardly any trace of fossils is seen in it, but some of the looser strata abound with shells. Among them there is a small species of Exogyra, which for its prominent, spiral beaks and general shape might easily be mistaken for a species of Chama or Diceras; it is very common, and in some localities occurs in great abundance. Together with this Exogyra, there is in most places a new species of Gryphæa; also a smooth and globose Terebratula, and occasionally a specimen of *Pecten quadricostatus.* These beds of soft marly limestone are not only seen every where on the mountains in the neighborhood of New Braunfels, but they extend north of this place about seventy miles as far as to the Piedernales river, every where containing the same fossils. Over the same wide range, there are other fossiliferous strata of an entirely different character. I saw them first in a deep ravine near the narrow rock-bound channel of the Guadaloupe, eight miles north of New Braunfels. One thick bed of compact limestone contains, in immense numbers, certain organic bodies of cylindrical shape. These fossils are generally an inch or two in diameter, twisted both ways, and mostly furrowed longitudinally on the surface. At first view I was rather puzzled as to their relations, but on closer inspection of their internal structure, it became evident that they must belong to the order of the Hippurites, that singular division of shells which gives the peculiar fossil character to the cretaceous formation of Southern Europe, from Lisbon in Portugal as far as Asia Minor along the Mediterranean. Some beautiful specimens of a real Hippurites resembling very much a species of Southern France, were afterwards met with. In the same beds of limestone with these Hippurites, several species of bivalve shells are found which belong to genera equally characteristic of the Mediterranean cretaceous formations, viz. Diceras and some analogous genera. At last in the same beds also occur a large Pecten of the same section as the Pecten quadricostatus, besides several univalves.

Some Hippurites and several species of the Diceras family, were also found on the Piedernales; so that it seems probable that the strata just described have a very extensive range.

Having presented the facts observed, I offer a few general conclusions from them. At first there cannot be the least doubt that all the strata just described are equivalent to the cretaceous formation of Europe. The identity in the general character of the fossils incontestibly proves it. It is more doubtful to which division of the cretaceous formation they ought to be referred. So much however is certain *a priori*, that they do not represent the lowest divisions of the cretaceous system; since among the organic remains there are no characteristic fossils of the lower green sand or of the gault. The fossils of the white marly limestone first mentioned indicate an age not older than that of the "chalk marl" of England in the series of the cretaceous deposits of Europe. We might even be inclined to believe those strata equivalent to the white chalk of Europe, if some of the most characteristic fossils of the chalk among them especially the *Belemnites mucronatus* were not wanting altogether. The system of strata partly consisting of compact siliceous limestone, and containing fossils of the Hippurite order, next described, belong still higher in the European series; for near New Braunfels they certainly lie above the marly limestone. From some observations however made at other localities, I have reason to believe that the two systems of strata are not every where so distinctly separated, and form together a single continuous succession of strata of nearly the same age; and with regard to the age we can at present only say that the beds belong to the upper division of the cretaceous formation. It is interesting to compare these cretaceous deposits with the cretaceous strata of New Jersey, Virginia, etc. In the latter regions we find beds of a loose calcareous marl and of ferruginous sand, representing the upper division of the cretaceous formation. In their fossils and also their mineralogical constitution they bear a striking analogy to some deposits of England and Germany. In Texas, we have a system of rocks which equally correspond to the upper division of the cretaceous formation, but of a very different character and not consisting like those just mentioned of loose unconnected materials, but partly at least a very compact siliceous limestone. By their fossils as well as the composition of the rocks they are closely allied to the cretaceous formation as it is developed in the south of Europe along the Mediterranean.

A new and interesting analogy in the geological constitution of the two continents has thus been ascertained, proving the general similarity of physical condition and of the laws of organic life in both hemispheres during the period when the cretaceous strata were originally deposited.

Still another observation of a general character remains to be stated respecting these cretaceous deposits. About 20 miles north of Fredericksburg, the new German settlement on the Piedernales river, a rock more than one hundred feet high with nearly perpendicular sides stands out from the ground. This rock which very probably is identical with that which has been laid down on the maps of Wilson and others as "the enchanted rock," consists of a rather coarse grained granite. I obtained specimens of the granite from some friends of mine who were on the spot, and ascertained also that beds of limestone extended to the very base of the rock. This fact in connexion with the other one that on the San Saba river, silver mines have been worked formerly by the Spaniards in a plutonic rock, seem to lead to the supposition that here on the tributaries of the Colorado we arrive at the boundary where the stratified rocks of the east side of the continent come in contact with the crystalline masses of the Rocky mountains. If this supposition is correct, it follows that the cretaceous formation is the only one of the whole series of stratified rocks which exists in this part of Texas. From the facts observed in Texas, we derive additional confirmation of the hypothesis long since made with great sagacity by M. Leopold von Buch and never refuted, that the oolite series of Europe have no equivalent on the American continent.

In the course of this summer I hope to extend my investigations to other parts of the country, and may be able then to give your readers some more satisfactory information about its geological relations.

ART. XXXIII.—*Fusion of Iridium and Rhodium;* by R. HARE, M. D., Prof. of Chemistry in the University of Pennsylvania.*

THIS communication respects mainly my success in fusing both iridium and rhodium, neither of which in a *state of purity*, had been previously fused. It may be supposed that the globule of iridium, obtained by Children's colossal battery, forms an exception; but the low specific gravity, and porosity, of that globule, may justify a belief that it was not pure; and at any rate, the means employed were of a nature not to be at command for the repetition of the process—so that iridium might *as well be infusible*, as to *be fusible only by such a battery*.

The first specimen of the last mentioned metal, on which I operated, was one given me by Mr. Booth, a former pupil of Wöhler, whom he had assisted in obtaining it by the excellent process devised by that distinguished chemist. This specimen

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* TO THE EDITORS.

Gentlemen—The facts and observations of which the accompanying communication is intended to give an account, having been communicated, as they occurred, at the meeting of the American Philosophical Society, were published in subsequent numbers of their bulletin in the spring and summer of 1842. Excepting in that work, I believe they have not yet been published. Under these circumstances, I trust that a communication embodying the statements made before the Society as above mentioned, may be deemed worthy of republication in your Journal. I have lately allowed Mr. Goetz, one of the contributors to the "Revue Scientifique," published at Paris, to make therefor a translation of this article, accompanied by a suitable letter to the editors.

I am, gentlemen, with esteem, yours very truly, R. HARE.

was fused in the presence of Mr. Booth. Subsequently I procured specimens, warranted pure, severally from the house of Pelletier at Paris, and from Messrs. Johnson & Cocke, London. Another specimen was given to me by a friend, who had received it as pure, from a source on which reliance may be placed; and lastly, I obtained myself, by Wöhler's process, a specimen of about sixty grains, from the insoluble residue of platinum ore. All the specimens thus procured, were found to be fusible under my hydro-oxygen blowpipe. The specimen obtained from Johnson & Cocke, after repeated fusions by which it was much consolidated, weighed sixty-seven grains. During fusion there appeared to be an escape of volatile matter, supposed to be osmic acid, arising from the presence of a minute portion of that metal, between which and iridium, an affinity of a peculiar degree of energy exists. At a certain point of the process, a reaction took place sufficiently explosive to throw a portion of the metal, in globules, off from the support. One of these, about twice as large as the head of a common brass pin, proved to be hollow. By prolonged and repeated fusion, the metal became more compact and more fusible.

Fused iridium has nearly the grain of soft cast steel, with the pale whiteness of antimony, and appears to be susceptible of a fine polish. Although as hard as untempered steel, it is somewhat sectile, since when split by means of a cold chisel, the edge penetrated about the eighth of an inch before a division was effected. By light hammering a corner was flattened without fracture, although under heavier blows the mass cracked. I infer that although nearly unmalleable and very hard, iridium may be wrought in the lathe.

I have already mentioned that I fused into a globule a specimen of iridium, obtained by me from the insoluble residuum of platinum ore by Wöhler's process. From this globule, while congealing, a portion ran out from the inside, leaving a cavity and covering one of its sides externally with an incrustation, among which crystalline spangles, or facets, were discernible. The specific gravity of the globule of iridium, from the specimen furnished by Messrs. Johnson & Cocke, was taken by Mr. T. R. Eckfelt, of the United States mint at Philadelphia and by Dr. Boyé, both having balances of the greatest accuracy and being very skillful in the employment of them. In the first instance there was a perfect coincidence in the results obtained, 21·83 being the numbers found by both of these gentlemen. Agreeably to another trial made by Dr. Boyé, using river water instead of distilled, the number was 21·78, water being in either case about sixty-eight with allowance for the difference of the water, and the temperature being above the standard of 60°. The specific gravity of the specimen, may then be estimated at 21·80.

The specific gravity of fused platinum, purified according to the instructions of Berzelius, before subjection to the hammer, proved in one specimen to be not more than 19·70, although by hammering it became equal to 21·23. It is with fused platinum that fused iridium should be compared. Of course the specific gravity of the last mentioned metal when both are obtained by fusion, may be assumed to be one tenth greater than that of the former. Moreover as this metal is the only impurity existing in the standard platinum of London, of Paris, or of St. Petersburg, it follows that a high specific gravity is not to be viewed as a proof of purity. Accordingly a specimen of platinum, purified from iridium by the Berzelian process and which had proved eminently susceptible of being beaten into leaf, was found only to be of the gravity of 21·16, while that of a specimen of standard Russian platinum, very brilliantly white, but inferior in malleability presented to me by his Excellency Count Cancrine, as a specimen of the purest platinum of the Russian mint, was 21·31.

Of rhodium, I have fused two specimens, one of five penny weights, purchased of Messrs. Johnson & Cocke, the other received through the same channel as the specimen of iridium above mentioned*. Rhodium is at least as fusible as iridium, both of the specimens alluded to, having been converted into fluid globules. That procured from Johnson & Cocke, gave a globule weighing ninety grains. On a second fusion, it formed a perfect globule as fluid as mercury; and yet in congealing lost its brilliancy by becoming studded with crystalline facets all over its surface, excepting the portion in contact with the support. The facets had the appearance of incipient spangles. The rapidity with which they were formed seemed to be anomalous. The mass being split by a cold chisel and viewed by a microscope, it

* One other larger specimen from the same source has been fused since the above was written.

appeared porous immediately beneath the facets. When the mass was first fused, I found by the gravimeter the specific gravity to be 11·0, which coincides with the observations of Wollaston. Yet by a careful trial made at the U. S. mint by Mr. Eckfelt, after the second fusion, and the formation of the facet, the specific gravity proved to be only 10·8. This is sufficiently explained by the porosity above mentioned. In fact the porosity to which rhodium and iridium are liable, may render it difficult to find specimens of precisely the same specific gravity.

In sectility, malleability and hardness, rhodium did not appear to differ much from iridium, but it is not of so pale a white as iridium. The one has the pale white of antimony, the other the ruddy hue of bismuth.

Osmiuret of iridium as existing in the native spangles associated with platina ore, or as otherwise obtained, is far more difficult of fusion than pure iridium. The propensity to assume the crystalline form, and to adhere to it, is even greater in this alloy than in the last mentioned metal. On first exposure to the most intense heat of the hydro-oxygen blowpipe, some slight appearances of fusion may be seen, and the spangles or grains may be made to cohere. Nevertheless it yields very slowly, and requires an expenditure of gas too great to be incurred unless it were for the purpose of once well determining the question of its ultimate fusibility. This object was obtained completely as respects a globule of forty-five grains in weight. The specific gravity of this globule appeared to be 20.4, but this result was evidently less than that which would have been obtained had there not been some minute cavities, which after splitting the globule, were detected by a magnifier.

The specific gravity of some large spangles of osmiuret of iridium from South American ore, was by Dr. Boyé found to be 19·835. That of some grains heavier but not so flat, presented to me by Count Cancrine, was found to be 20.938.

That the alloy of iridium with osmium should be more difficult to fuse than pure iridium, leads to the inference that osmium must be the most infusible of the metals, although, like carbon, very susceptible of combustion, and capable, like that infusible non-metallic radical, of forming a volatile peroxide. Of course its liability to oxydizement, would render it impossible to fuse it by the hydro-oxygen blowpipe, of which the efficacy requires the simultaneous presence of oxygen and the most intense heat. It might be fused by exposure in vacuo to the discharge of a powerful voltaic series, by means of the apparatus of which a description with engravings has been given in a recent volume of the Transactions of the American Philosophical Society, and republished in this Journal for 1841, vol. xl, p. 303.

I have obtained osmium by heating the osmiate of ammonia in a glass tube with sal ammoniac, agreeably to the instructions given by Berzelius. In this way a result was obtained which the information given by that distinguished chemist, had not led me to anticipate. The tube became coated with a ring of osmium, which it would be impossible by inspection merely, to distinguish from the arsenical ring on the peculiar features of which, reliance has been placed for the detection of arsenic.

It follows from my experiments and observations, that of all metallic bodies, osmiuret of iridium is the most difficult to fuse; that rhodium and iridium are both fusible by the hydro-oxygen blowpipe, properly employed; that the former has the rosy whiteness of bismuth, the latter the pale white of antimony; and that both of them are slightly sectile though extremely hard and nearly unmalleable; that iridium *merely fused*, is heavier than platinum *condensed by the hammer*. Thus it follows from my experiments and from the recent observations of Breithaupt, on some specimens of native iridium, that the metal whether in this state or pure as obtained by chemical skill and consolidated by fusion, must be allowed that preëminence in density which, until of late, was given to platinum.

It may be proper to add that subsequently to the writing of the preceding narrative, receiving some large quantities of iridium and rhodium, from Johnson and Cocke, my experiments were successfully repeated on a larger scale, but without any result besides that of confirming the facts above stated.

ART. XXXIV.—*On the Meteoric Iron of Texas and Lockport;* by Prof. B. SILLIMAN, Jr., and T. S. HUNT.

SEVERAL notices of the Texas Iron will be found in the former series of this Journal.* It was at first said to be not nickeliferous, but Prof. Silliman soon proved this statement to be an error. We are indebted to the united cupidity and ignorance of those who procured this fine specimen of celestial matter, for its being made known to science. Two costly, armed, and well organized expeditions were sent out for it, and inconceivable difficulties were encountered in a wilderness among hostile savages, before they at last succeeded in bringing it nearly two thousand miles over land to the Mississippi, elated with the confident delusion that it was *platinum.* We have in our possession a large number of original manuscript documents, which collectively constitute a full history of the discovery and procuring of this specimen. Our limits do not permit their publication, nor is it necessary that even a full abstract of them should be given. A sufficient account of these papers will be found in vol. viii, p. 218, of this Journal.

After this mass was presented to the collection in Yale College by Mrs. Laura Gibbs—widow of Col. George Gibbs, so well known to all cultivators of mineralogy—a portion of the smaller end was sawn off with much difficulty, which when reduced to a smooth surface, gave a brilliantly polished face about eight inches in diameter, on which is engraved an inscription commemorative of Col. Gibbs and the donor, and the weight of the mass—1635 *pounds.* This section revealed in a very perfect manner the crystalline structure of the mass, by the broad octahedral cleavages which appeared at one or two points where a fracture was made. By a planing machine, the surface of the

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* 1. "*Notice of the Malleable Iron of Texas,*" viii, 218, (1824.) This notice contains a historical account of the discovery and of the expeditions of Glass and John Maley to obtain the mass now in the Yale College mineralogical collection.

2. "Analysis of the meteoric iron of Louisiana," by C. U. Shepard, xvi, 217, 1829.

3. A notice of the presentation of this mass to Yale College by Mrs. Gibbs, xxvii, 382.

4. Some further facts concerning the locality and other masses of metallic iron in Texas, xxxiii, 257.

portion which was removed was rendered quite smooth and level, and after being well polished, it was washed with dilute nitric acid. The lines of crystallization at once made their appearance in the most beautiful manner. The action of the acid was continued until the lines were etched boldly enough, to take ink and give an impression. The mass was so imbedded in type metal as to be capable of passing the copper plate press, and the impressions were then taken, of which the accompanying plate is one. This mode of proceeding, causes the iron to record its own crystalline character in the most faithful manner. This crystalline structure of meteoric iron is found in *most* but not in *all* the specimens of such iron which have been examined. Those who have seen the work of Schreibers* will remember the beautiful structure of the Agram iron, and many others, developed by acids. The Alabama meteoric iron† has however no distinct crystalline structure. The Columbia, South America, has very little; and the supposed meteoric iron from Oswego,‡ or Scriba, in New York, has none.

The Texas mass is a magnet; its greater diameter is nearly in the magnetic meridian, as it is now placed, and in this situation it possesses true polarity. One of the artizans employed in finishing up the polished face, noticed that the filings of the iron arranged themselves on the face in lines parallel to the crystalline planes, as if influenced by magnetic attraction. No large masses of pyrites were observed in this mass, though so abundant in the Lockport iron. This mineral is however not entirely wanting in the Texas iron, as is shown by chemical examination; and one or two small lumps of pyrites were encountered by the saw, in cutting the section before mentioned.

Chlorine.—Very soon after the section was made, both of its opposite faces were observed to be bedewed with moisture. This was washed off with distilled water and the washings tested for chlorine by nitrate of silver, with abundant evidence of the presence of this element. This exudation soon ceased, and the chippings of the iron examined by solution in pure nitric acid, and testing with nitrate of silver, gave no further evidence of the presence of chlorine. We conclude therefore that this iron prob-

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* Der Meteoreisen. † This Jour., 1st. Ser., xxxiv, 332.

‡ This Jour., 1st Ser., xl, 366.

ably contains in its interior parts, a small portion of chlorine, which has escaped from its surface, and hence only the deep section of the mass, gave evidence of its presence.

The frequent chemical examinations, by able investigators, of meteoric masses, have shown that their mode of combination is frequently peculiar, but so far no new elements in addition to those before known, have rewarded the search. Although our ideas of the unity and simplicity of cosmical laws are thus enlarged, we are not yet warranted in the conclusion that the matter of meteors is in all respects the same as that of our earth. From the fact that almost yearly additions are made to our list of elements, in minerals brought from parts of the earth long known and seemingly well investigated; may we not hope that these celestial visitors may yet present us from the distant regions of space, with some element before unknown? Perhaps an obscure affirmative answer is given to this question, by a fact noticed in this paper as observed in the Texas iron. Thus far our search has been far too limited to authorize us in asserting from the *negative* evidence obtained, that new elements do not exist in meteors. The attention of chemists has been too generally confined to the detection of a few bodies, which are already recognized as ingredients of meteoric masses, and no substance has for a long time been added to that list.

We have spent some time in the examination of various meteoric irons and stones, and although we have little that is new to present, our researches have not been without interest as showing the great general similarity in composition, which characterizes this remarkable class of bodies. We present now only the results obtained on the Texas and Lockport irons.

Examination of the Texas Iron.

When this iron is dissolved in hydrochloric acid (A) a very small amount of insoluble matter remains, being only about ·5 per centum. This residue is a black powder, (B) interspersed with some scales of a leaden gray and containing numerous brilliant metallic plates of a silvery whiteness. It is almost entirely magnetic iron, the brilliant scales being either metallic nickel or an alloy of iron with a large portion of nickel.

The hydrochloric solution (A) afforded no precipitate when treated with sulphuretted hydrogen; and the iron being thrown down from a portion of it by ammonia, the filtrate was examined in vain for cobalt, manganese and zinc.

The insoluble black powder (B), when digested in aqua regia, was partly dissolved, while another portion remained, consisting of flakes of graphite, or at least of a very incombustible carbon containing a little iron. Sulphuretted hydrogen passed through the solution gave a yellowish brown precipitate, which was dissolved by hydrosulphuret of ammonia (C), leaving only a trace of sulphuret of *copper*. The soluble portion (C) was precipitated by acetic acid, and its color appeared to be orange, but was somewhat obscured by free sulphur. The results obtained from its examination were anomalous and rather unsatisfactory. It fused with nitre and carbonate of soda, forming a mass which was soluble in water without residue, and whose solution nitric acid did not sensibly affect. Treated with nitrate of silver and a dilute solution of ammonia, with reference to the detection of arsenic acid, it gave a *white* precipitate in place of the *red-brown* of the arseniate of silver. A part of the solution was treated with acetate of lead, and the precipitate obtained, when reduced before the blowpipe, gave a globule of lead, which at a red heat evolved white inodorous fumes resembling antimony. A want of sufficient material prevented any further examination, and the question of its true nature is consequently yet unsettled. Antimonic acid is precipitated from its salts by any strong acid, which was not the reaction of the substance under examination. If not antimony, it is probably a new body hitherto unexamined, although such a conclusion requires further evidence to warrant its correctness.

The analysis of 100 parts of this residue (B) gave—

Iron,	31·2
Nickel,	42·8
Phosphorus,	4·
Carbon,	5·
Antimony? and Copper,	9·3
	92.3

The iron in (B) is doubtless in the state of magnetic oxyd, and as such would make up the deficiency in this analysis.

The proportion of nickel and iron in the Texas meteorite seems to vary. The mean of several analyses gives us—

Iron, ...	90·911
Nickel, ...	8·462
Insoluble Phosphurets, &c.	0·500
	99·873

The nickeliferous iron, or that part of the mass most rich in nickel, seems to have been segregated from the general mass, and forms the elevated lines of brilliant whiteness which appear on etching a polished surface of the metal.

Examination of the Lockport Iron.

The history of this mass was given in this Journal, 1st Series, xlviii, 390, and also a preliminary analysis by the late D. Olmsted, Jr. For the sake of comparison, we again introduce the figure, showing its crystalline structure, and the white and yellow pyrites which it contains.

A quantity of this iron in small fragments was dissolved in hydrochloric acid, with the aid of a gentle heat; the solution was easily and rapidly effected, and the gas given off, being passed through a solution of acetate of lead, was found to contain some sulphureted hydrogen, arising from the solution of the pyrites with which the mass is impregnated. A small insoluble residue remained in the solution, which was digested with a fresh portion of dilute acid without any effect. It was then collected and dried; it was partly light and flocculent, but the larger portion of it consisted of blackish gray scales, nearly all of which was attracted by the magnet. This insoluble residue makes up 1·4 per centum of the entire mass of the iron.

It dissolved in aqua regia, leaving a small amount of finely divided chestnut brown matter, so intimately suspended in the solution that it did not subside in twelve hours, but still gave a brown tint to the liquid. When ignited, it glowed for a moment and left a light reddish ash. It dissolved with effervescence in pure fused carbonate of soda and the mass treated with water, gave flocculi of silicic acid. These characters show the reddish brown matter to have been either silica with a trace of carbon, or silicon, which last Prof. Shepard has already shown to exist, in the Oswego iron.*

Hydrosulphuret of ammonium, threw down the metals from the solution in aqua regia, and the filtrate from this was found to contain phosphoric acid. The metallic sulphurets consisted solely of iron and nickel. A careful examination failed to detect either cobalt, manganese, or any other metal.

The original hydrochloric solution gave with sulphureted hydrogen, a small precipitate, of which a part was taken up by alkaline sulphurets and the residue consisted only of *copper*. The soluble part was too small to obtain from it definite reactions. It was probably arsenic.

One hundred parts of this insoluble residue gave—

Iron, ...	44·1
Nickel, ...	24·5
Phosphorus, ...	11·4
Silicon?	10·00
	90·00

The considerable deficiency in this result is probably due to the fact that the iron occurs in the compound, as magnetic oxyd, which is here estimated as metallic iron. The quantity of

* See this Journal, First Ser., vol. xl, p. 366.

phosphorus is very little more than is required to form a phosphuret with the nickel (Ni_3P), or with about half of the iron, and it is certainly difficult to conceive of the iron as retaining its magnetic condition, and resisting the action of hydrochloric acid, unless we suppose it to be in the state of magnetic oxyd.

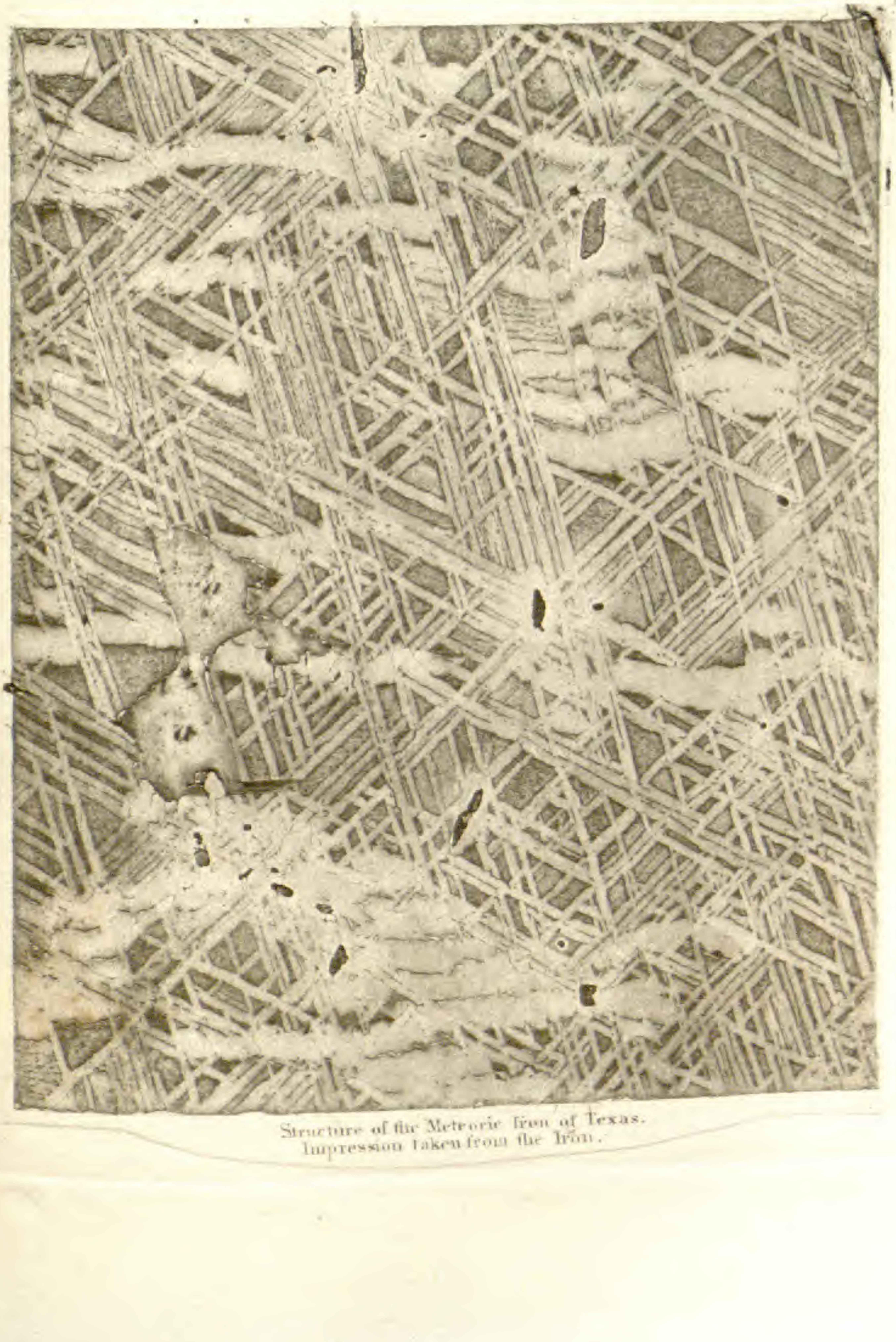
We may present the following as the constitution of the entire iron.

Iron, ...	92·583
Nickel, ...	5·708
Copper, } Arsenic, }	Traces.
Insol. matter, ...	1·4
	99·991

We have as yet no researches on the composition of the pyrites contained in these irons, which if we can obtain a sufficient quantity of the material, will be discussed on a future occasion.

It will be seen that we have not noticed the existence of cobalt in either of these masses, and as it has generally been spoken of, as a pretty constant ingredient in meteoric iron, it will be well to state the manner in which the examination for this metal was conducted. The iron was separated from the hydrochloric solution, previously peroxydized, either by an alkaline succinate, or as a basic salt by the process of Scherer; the metals still in solution were then precipitated as sulphurets. From the solution of these rendered ammoniacal, the nickel was thrown down by caustic potash, agreeably to the directions of Phillips, when hydrosulphuret of ammonium gave no precipitate in the filtrate, even after standing *one or two hours.* A similar mode of proceeding with both of the hydrochloric solutions, and those of the residue insoluble in that acid, gave the same results, and was supposed to prove the absence of cobalt. The oxyds of nickel and iron thus obtained, when examined by the blowpipe, gave no evidence of this metal.

Yale College Laboratory, July 27, 1846.



Structure of the Meteoric Iron of Texas.
Impression taken from the Iron.

ART. XXXV.—*Report on Meteorites.*—Read before the American Association of Geologists and Naturalists, at their meeting in New York, held September 2d, 1846; by CHARLES UPHAM SHEPARD, M. D., Professor of Chemistry in the Medical College of South Carolina and in Amherst College, Mass.

THIS report was undertaken with a view to collect all the information within reach, relative to the meteoric productions of the United States, (or at farthest those of North America.) In the prosecution of the work, however, I have been led to pay attention to meteorites generally; at least so far as to classify and describe the various mineral species they contain, to give a view of their chemical constitution, and to treat of some of those relations familiar to us as geological so far as these are common to meteor-masses.

PART I.

Description of the Mineral Species found in Meteor-Masses.

The number of species recognized in these bodies is *thirty-seven*. Their natural history properties readily permit them to be distributed into the three classes, and under thirteen of the orders of the mineralogical system of our earth. But as meteorites are now, by universal consent, admitted not to be of terrestrial origin, it would obviously be improper to describe the species of which they consist under the science of mineralogy, although we may perhaps be allowed to borrow temporarily the names of its orders; since, in the use proposed, no change in their significance is to be made. The natural history treatment of the meteoric species will therefore constitute a new science, for which the name ASTROLITHOLOGY is suggested, (from αστὴρ a meteor, λιθος a stone, and λογος a treatise.) The following is a tabular view of the systematic arrangement of the species.

CLASS I.

Order 1st, Gaseous.

Sp. 1. Sulphurous Acid.

Order 2d, Soluble.

Sp. 2. Epsom-salt. Sp. 4. Vitriolic Nickel.
Sp. 3. Glauber's salt. Sp. 5. Copperas.

Sp. 6. Hyposulphite of soda, (nov. sp.)
Sp. 7. Hyposulphite of magnesia, (nov. sp.)
Sp. 8. Chloride of Iron.
Sp. 9. Chloride of Nickel.
Sp. 10. Chloride of Cobalt.
Sp. 11. Chloride of Calcium.
Sp. 12. Chloride of Magnesium.
Sp. 13. Chloride of Sodium.
Sp. 14. Soluble Silica, (nov. sp.)

CLASS II. *Order* 1*st*, *Haloide.*

Sp. 15. Apatite?
Sp. 16. Apatoid, (nov. sp.)
Sp. 17. Sphenomite, (nov. sp.)

Order 2*d*, *Ochre.*

Sp. 18. Dyslytite, (nov. sp.)

Order 3*d*, *Mica.*

Sp. 19. Mica.

Order 4*th*, *Spar.*

Sp. 20. Iodolite, (nov. sp.)
Sp. 21. Chladnite, (nov. sp.)
Sp. 22. Anorthite.
Sp. 23. Pyroxene.
Sp. 24. Chantonnite, (nov. sp.)

Order 5*th*, *Gem.*

Sp. 25. Peridot.
Sp. 26. Garnet.

Order 6*th*, *Ore.*

Sp. 27. Limonite.
Sp. 28. Chrome-ore.
Sp. 29. Magnetic Iron.

Order 7*th*, *Metal.*

Sp. 30. Native Iron, (nov. sp.)
Sp. 31. Nickeliferous Iron.
Sp. 32. Native Steel, (nov. sp.)
Sp. 33. Nickeliferous Steel, (nov. sp.)

Order 8*th*, *Pyrites.*

Sp. 34. Magnetic Iron-pyrites.

Order 9*th*, *Glance.*

Sp. 35. Schreibersite, (nov. sp.)

CLASS III. *Order* 1*st*, *Sulphur.*

Sp. 36. Sulphur.

Order 2*d*, *Graphite.*

Sp. 37. Plumbago.

Descriptions of the species in the order of the foregoing arrangement.—Such of the species as are common to mineralogy will be passed over with slight descriptions.

1. *Sulphurous Acid.*—This gas is freely evolved from a majority of meteoric stones, at the time of their descent. A fresh fracture or slight friction develops its odor, very perceptibly, in the Bishopville (S. C.) stone.

2. *Epsom Salt.*—This is dissolved out by water from the Alais stone, (BERZELIUS,) as also from that of Bishopville.

3. *Glauber's Salt.*—Dissolved out from the Bishopville stone.

4. *Vitriolic Nickel.*—Dissolved out from the Alais stone in small quantity, (BERZELIUS.)

5. *Copperas.*—Dissolved from pyritic masses of Cocke Co., Tenn. iron.

6. *Hyposulphite of Soda.*—Dissolved from the Bishopville stone.

7. *Hyposulphite of Magnesia.*—Dissolved from the Bishopville stone.

8. *Chloride of Iron.*—Dissolved from the Claiborne iron, (JACKSON,) and from Asheville (N. C.) iron.

9. *Chloride of Nickel.*—Dissolved from the Claiborne iron, (JACKSON.)

10. *Chloride of Cobalt.*—Contained in red rain which fell during half an hour at Blankenberg, Pays Bas., Nov. 2d, 1819, (MM. MEYER and STOOP.*)

11. *Chloride of Calcium.*—Dissolved out from the Bishopville stone.

12. *Chloride of Sodium.*—Found in the Stannern stone, (SCHEERER.)†

13. *Chloride of Magnesium.*—Dissolved out from the Bishopville stone.

14. *Soluble Silica.*—Dissolved out from the Bishopville stone.

15. *Apatite?*—In small, yellowish-green, transparent grains, (H=5·0,) found in the Richmond stone.

16. *Apatoid, (Shepard.)*—Thus named from its resemblance to apatite. It occurs in very minute quantity, in small, yellow,

* Jour. de Phys., t. lxi, p. 469.

† Chladni, ueber Feuer-meteore, Wien 1819, p. 46.

semi-transparent grains in the Richmond stone, and still more sparingly in that of Bishopville. H. = 5·5. It fuses partially before the blowpipe on charcoal, at the same time turning black. With borax it dissolves into a yellowish-brown glass. It does not contain phosphoric acid.

17. *Sphenomite*, (*Shepard.*)—Thus named from its resemblance to sphene. It occurs in brownish-grey (with a tinge of yellow,) thin, tabular crystals. H. = 5·5. Implanted on crystals of black pyroxene, and associated with anorthite in the Juvenas stone. Before the blowpipe, it fuses readily into a black glass, which is magnetic. It dissolves in borax with effervescence, presenting the reaction of sphene. It is soluble in nitric acid, with the exception of a heavy white powder, insoluble in ammonia. The solution contained silicic acid and lime.

18. *Dyslytite*, (*Shepard.*)—Named from δυσλυτος, insoluble. It is a blackish-brown powder, which is brought to view by the action of acids, in the greater number of meteoric irons,—being present in them in proportions, varying from 0·25 to 2·25 p. c. It consists, according to Berzelius, of a phosphuret of iron, nickel, and magnesium.*

19. *Mica.*—Found, in a single instance, in small, brownish-grey, pearly, scales, attached to a mass of nickeliferous iron weighing 54 grs., from the meteoric stone of Weston.

20. *Iodolite*, (*Shepard.*)—Named from ιωδης, violet-colored, on account of its violet color. Massive; in angular, somewhat rounded grains, (the largest $\frac{1}{8}$th of an inch in diameter.) Three sets of cleavages, whose relations to one another are not clearly to be made out. Color, pale smalt-blue. Lustre, vitreous: semi-transparent: brittle. H. = 5·5 . . . 6·0. Before the blowpipe, it fuses easily and attended with ebullition, into a blebby, colorless glass, which while warm, retains a pale amethystine tinge. With borax, it dissolves slowly into a perfectly colorless and transparent globule. It does not act upon clean iron wire, when heated in powder with boric acid. In the state of powder, it was slightly acted upon by hydrochloric acid. Ammonia threw down silica from the solution, which however did not appear to retain either

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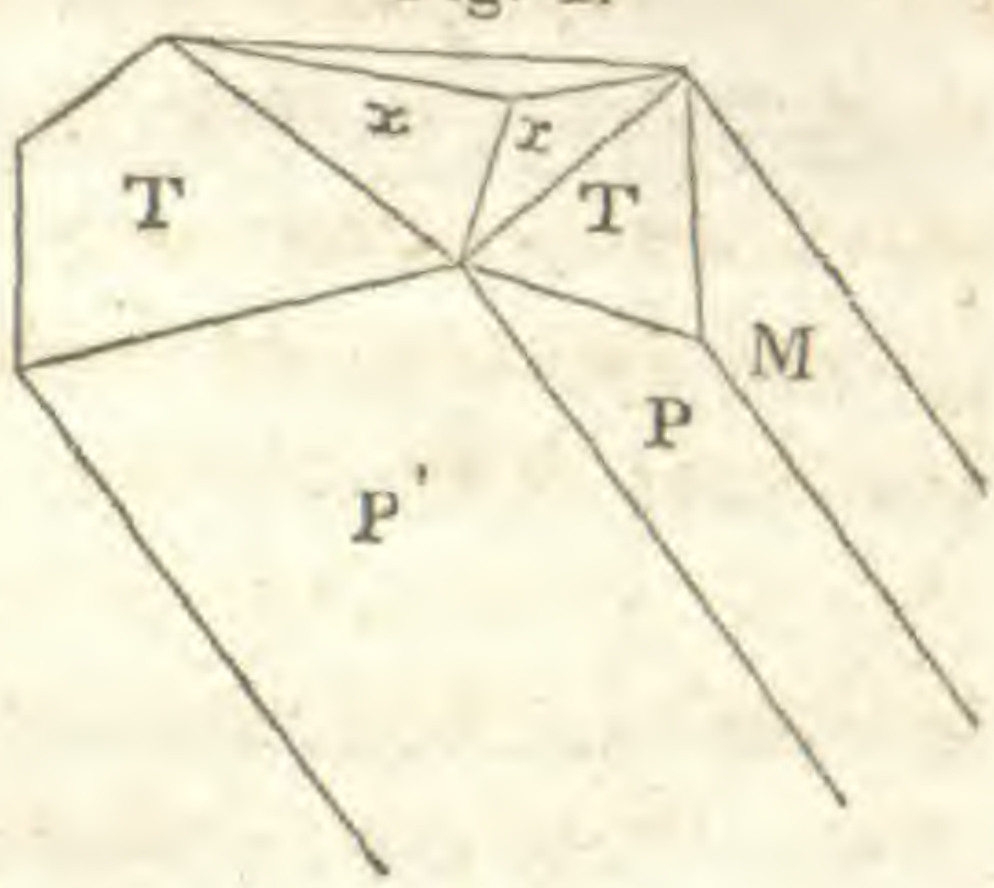
* Whether the silicon I have found in this insoluble residue in the Asheville iron forms an ingredient in the present species, or belongs to an independent compound, I am unable at present to determine.

lime, or magnesia. It is found in small quantity, diffused through chladnite in the stone from Bishopville.

21. *Anorthite.*—In exceedingly minute, transparent crystals of the form here figured. P on M = 94.* Also massive, in the Juvenas stone.

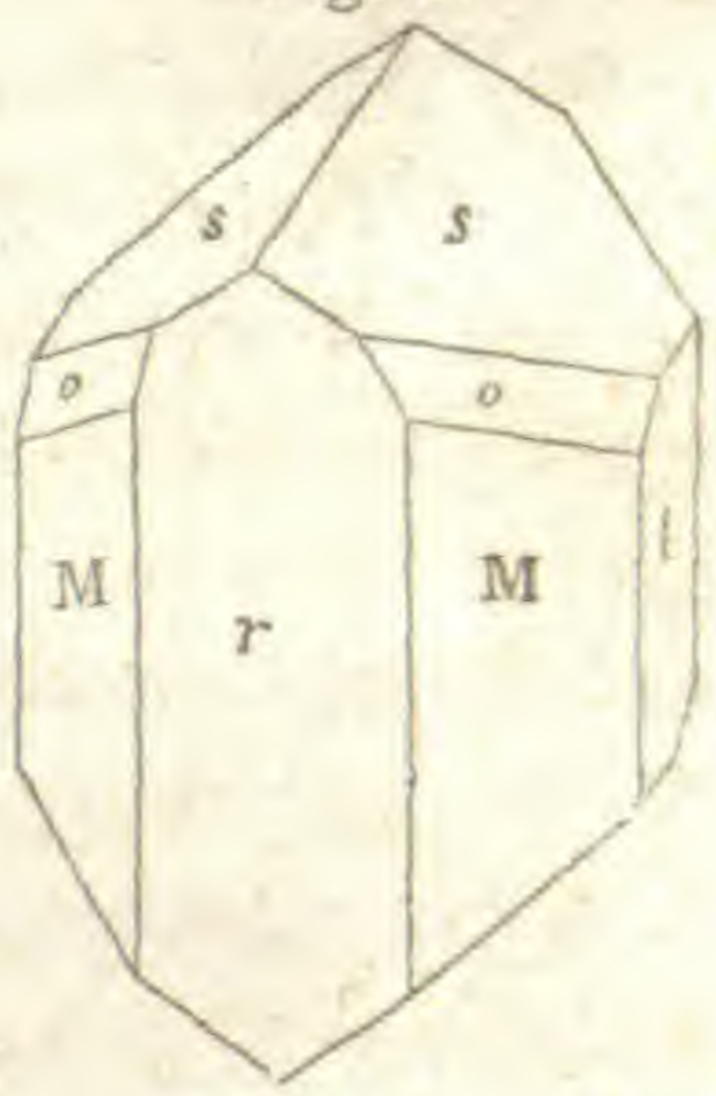
Fig. 1.



22. *Chladnite, (Shepard.)*—This species is named in honor of Chladni, the scientific founder of this department of knowledge. It occurs in imperfect crystals, some of which are nearly an inch in diameter, whose primary form is a doubly oblique prism. Their general figure approaches very closely to that of some of the most usual forms of feldspar and albite. The natural faces are too rough to allow of measurement. By cleavage, which is effected with great facility, angles of 120° and 60° are readily obtained. Color snow-white, rarely with a tinge of grey. Lustre pearly to vitreous. Translucent, (in undecomposed fragments semi-transparent.) H. = 6·0...6·5. Very brittle. Masses half an inch in diameter are easily crushed between the fingers. Sp. gr. = 3·116. Alone before the blowpipe on charcoal, it fuses without difficulty and with phosphorescence, into a white enamel; with borax very slowly, into a transparent glass. It is a ter-silicate of magnesia. It forms more than two-thirds of the Bishopville stone.

23. *Pyroxene.*—This species is found in very distinct, black crystals in the Juvenas stone, having the form of the figure in the margin (Rose). It likewise occurs in large grained, greenish black, individuals in the Stannern stone, and of a pearl-grey color in that of Chassigny and many others. Fig. 2.

Fig. 2.



24. *Chantonnite (Shepard).*—Named from the Chantonnay stone, in which it is found, forming compact, black veins and angular shaped masses. Fracture subconchoidal. H. = 6·5...7·0. Sp. gr. = 3·48. Before the blowpipe, it melts on the edges into a dull, black slag.

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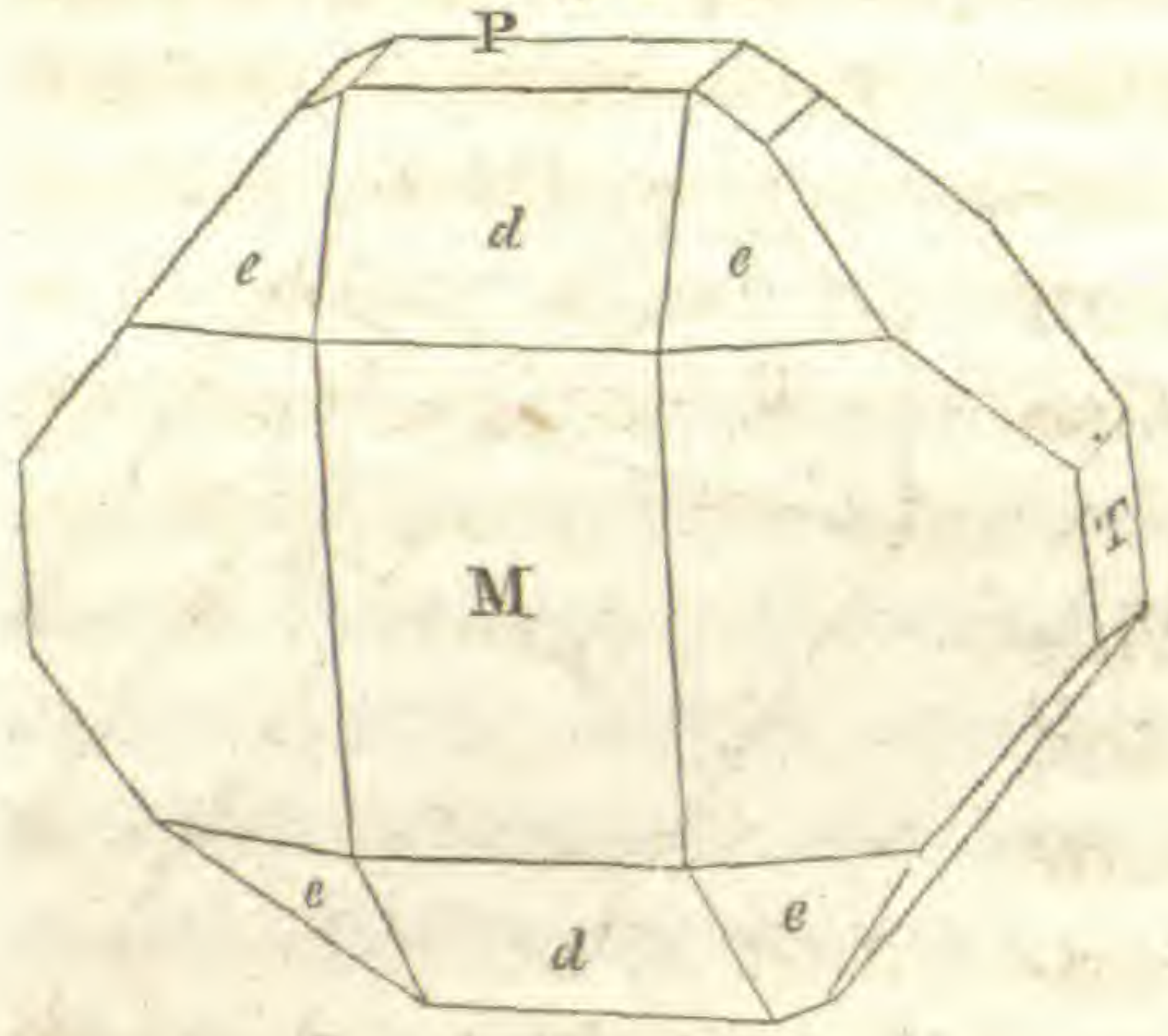
*Prof. G. Rose had observed twin-crystals of this mineral in the Juvenas stone, but he had suggested that they belonged to the species Labradorite. Ann. de Ch. et de Phys, Tom. xxxi, p. 81.

Fig. 3.

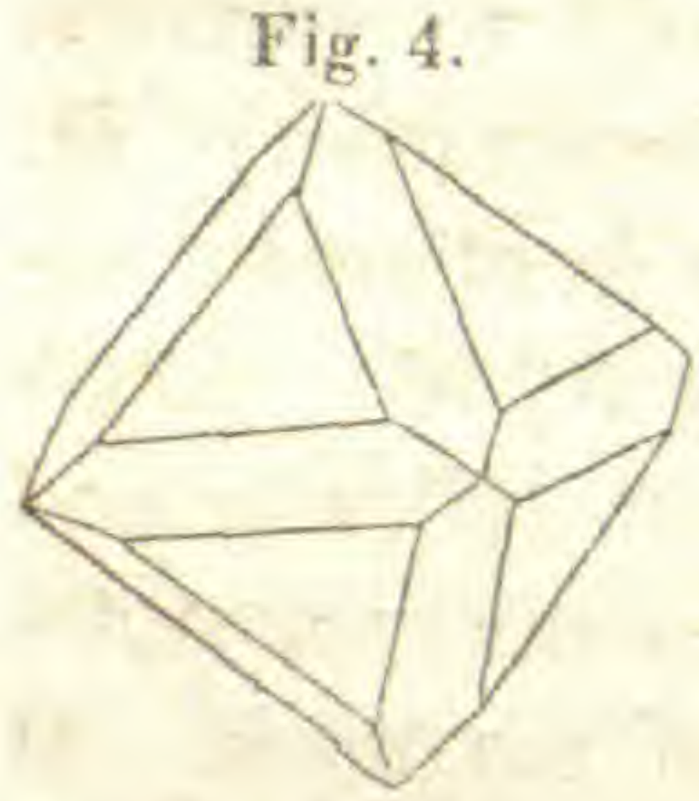


25. *Peridot.*—In very perfect crystals, (fig. 3, Rose), and in rounded, transparent grains in the iron of Krasnojarsk; also in irregularly shaped individuals of a pale, greenish yellow, or greyish white color, diffused through most of the meteoric stones.

26. *Garnet.*—In small, rich red grains, in no way distinguishable from the variety pyrope, either in hardness, color, fracture, or behavior before the blowpipe. In the Nobleboro stone.

27. *Limonite.*—In the form of iron-ochre upon the outside of the iron-masses, and of iron rust upon the fresh fracture of several of the stones.

Fig. 4.



28. *Chrome-ore.*—In crystals (fig. 4) in the Ensisheim stone, and in grains, in that of Chassigny. It likewise occurs in numerous meteoric irons.

29. *Magnetic Iron.*—Found massive in the seams and coatings in the iron of Scriba; also in the form of a black powder (mixed with dyslytite) as a residuum after the solution of certain irons in the acids.

30. *Native Iron.*—Massive. Sp. gr. = 7·26...7·5. Color iron-grey. Tough. Fracture hackley; subfibrous to granular. When etched, it exhibits on its polished surfaces, numerous shining, steel-like angular freckles, resembling the shining points which appear in certain nickeliferous irons, especially in the spaces between the raised silvery lines in the Burlington iron. Scriba, N. Y., and Walker Co., Ala.

The absence of nickel, chrome and cobalt in the Scriba iron, rendered its meteoric origin for a time doubtful; but the subsequent discovery of the Walker Co., Ala. mass, (weighing 165 pounds, and therefore too large to have been the product of the forge, and found in an unsettled region where iron-works never existed, moreover possessing the drop-shaped figure of several acknowledged meteor-masses,) can leave no doubt of its extra-terrestrial source.

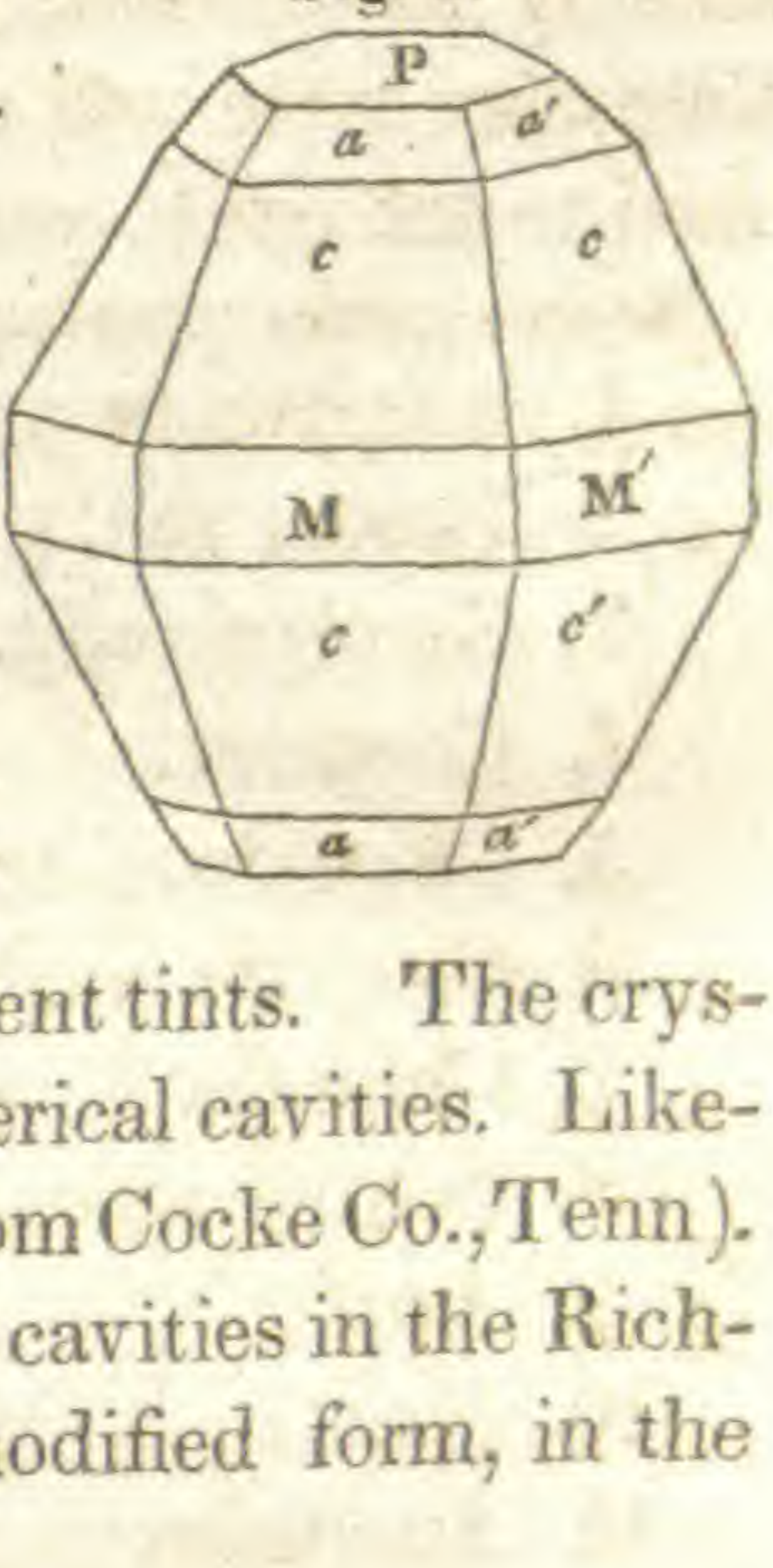
31. *Nickeliferous Iron.*—Under this name are probably included two or more species, which will hereafter be distinguished from each other. Sp. gr. = 6·5...8·0. Generally very crystalline, though sometimes nearly compact. When polished surfaces of this alloy are acted upon by dilute nitric acid, they generally afford very beautiful Widmannstättian figures; the precise arrangement of which is rarely identical, except in irons from one and the same fall.

32. *Native Steel.*—Massive. Highly crystalline: in laminæ generally parallel, sometimes confusedly crossing. H. = 6·0...6·5. Sp. gr. = 7·33...7·4. Color steel-grey. It yields very delicate crystalline lines on being etched. Randolph Co., N. C., and Bedford Co., Va.

33. *Nickeliferous Steel.*—In structure, it much resembles native steel. H. = 6·5. Sp. gr. = 7·117. Color steel-grey, inclined to pinchbeck-red. It contains (beside iron and carbon) nickel, copper and cobalt. Otsego Co., N. Y.

34. *Magnetic Iron Pyrites.*—Primary form, rhomboid. Secondary form, a modified six-sided prism. See fig. 5.

Fig. 5.



M on c = 153° 30′.

c on a = 117 30.

Cleavage imperfect. Brittle. Lustre steel-like and splendent. Color steel-grey upon the crystalline faces; copper-yellow on fractured surfaces. Very liable to tarnish; of which, steel-blue and red form the most frequent tints. The crystals are generally hollow, or possessed of spherical cavities. Likewise massive and foliated. Sp. gr. = 4·454, (from Cocke Co., Tenn).

The crystals above described, occur lining cavities in the Richmond stone:* also, under a more highly modified form, in the Juvenas stone.†

35. *Schreibersite, (Shepard).*—Named in honor of the late Carl von Schreibers, Director of the Imperial Cabinet at Vienna, and a well known author on meteorites. In small, deeply striated prisms; angles indeterminate; traces of cleavage parallel with sides of prism. H. = 4·00. Lustre imperfectly metallic. Color brownish black. Streak unaltered. Opake. Brittle. Before the blow-

* See Amer. Jour, 1st Ser., xvi, 201.

† Ann. de Chim. et de Phys., t. xxxi, p. 87.

pipe, it emits sulphurous fumes; and flows without ebullition into a black glass, which is magnetic. With borax, it melts into a deeply yellow colored globule while hot, which on cooling becomes paler, and often shows a tinge of green. With tin, it forms a glass colored by chrome. The iron present, appears to be accidental, arising from the adhesion of magnetic iron pyrites; and the mineral will probably be found on complete analysis to be a sesqui-sulphuret of chromium. Found in small grains (the largest about the size of a rice-grain) in the Bishopville stone.

36. *Sulphur.*—This mineral occurs in small, semi-transparent grains and in powder, diffused through the Bishopville stone.

37. *Plumbago.*—Found in thin coatings between the layers of meteoric iron, and in little almond-shaped balls, dispersed through the same, in the Cocke Co., Tenn. iron.

As the whole number of well established mineral species belonging to mineralogy does not exceed three hundred and seventy, it will appear from the foregoing, that the meteoric species already recognized, equal one tenth those of our earth. The following table will show how far the meteoric species are common to the earth, and how far they are peculiar to the meteors.

Meteoric species common to the earth.	Meteoric species peculiar to meteor-masses.
1. Sulphurous acid.	1. Vitriolic nickel.
2. Epsom salt.	2. Hyposulphite of soda.
3. Glauber's salt.	3. Hyposulphite of magnesia.
4. Copperas.	4. Chloride of iron.
5. Chloride of magnesium.	5. Chloride of nickel.
6. Chloride of sodium.	6. Chloride of cobalt.
7. Chloride of calcium.	7. Apatoid.
8. Soluble silica.	8. Sphenomite.
9. Apatite?	9. Dyslytite.
10. Mica.	10. Iodolite.
11. Anorthite.	11. Chladnite.
12. Pyroxene.	12. Chantonnite.
13. Peridot.	13. Native iron.
14. Garnet.	14. Nickeliferous iron.
15. Limonite.	15. Native steel.
16. Chrome-ore.	16. Nickeliferous steel.
17. Magnetic iron.	17. Schreibersite.
18. Magnetic iron pyrites.	
19. Sulphur.	
20. Plumbago.	

The following is a list of seven of the most abundant of the meteoric species, (which are enumerated in the supposed order of their prevalence,) in the aggregate of meteor-masses at present known.

1. Nickeliferous iron.	5. Anorthite.
2. Peridot.	6. Native iron.
3. Pyroxene.	7. Chladnite.
4. Magnetic iron pyrites.	

And of these, it is probable, that No. 1 constitutes $\frac{9}{10}$ths the weight of all known meteor-masses; while the seven species taken together, form $\frac{19}{20}$ths of such masses.

The four species out of these seven which are common to the earth, (peridot, pyroxene, magnetic iron pyrites, and anorthite,) form too insignificant a part of the crust of our globe to enable us to give, even a conjectural expression, in numbers, of their amount.

The contrast is therefore very marked between the mineral composition of the meteor-masses and of our earth. A species whose specific gravity is above 7, and which is metallic in its character, forms $\frac{9}{10}$ths of the former, while all the analogous species (i. e., those belonging to the order metal,) taken together, do not probably constitute $\frac{1}{100000}$th part of our globe! This remarkable discrepancy however will be much diminished, when allowance is made for the loss of all those meteoric stones which have fallen in early times, prior to the period in which mankind have begun to collect and preserve them. From the peculiar chemical composition of meteoric stones, it is plain, that unless collected soon after their fall, they would cease to be cognizable: whereas the iron-masses are capable of withstanding almost indefinitely, the action of the atmosphere and other destructive agencies to which they may be exposed after contact with our earth.

It is probable then that $\frac{99}{100}$ths, at least, of the meteor-masses known, fell in early times; some of it perhaps, anterior to the existence of man on the earth: and if we would form an idea of the correspondence between the metallic and the stony meteors of those times, we can only do so by comparing the ratio between the two during a fixed modern period, within which the masses of both kinds have been observed. Taking the last one hundred years with such a view, we find in the weight of the two iron-falls (Croatia, 1752, and Tennessee, 1835) as set off against that of all the stones for the same length of time, a ratio approximating that of one (for irons) to twenty (for stones.)

The preponderance of the stony minerals in meteor-masses would also appear considerably greater, if we could correctly allow for the immense loss of matter which on the explosion of a meteor, must often accrue, in the pulverization of a body so weakly coherent as is the majority of the stones. The clouds from whence the showers of stones have so often been seen to issue, may be composed of the fine dust which has resulted from the complete rending of such bodies: while numerous accounts are on record, of the precipitation for hours together and over wide areas of country, of a fine impalpable powder, whose chemical composition has been found, in the general, to correspond with that of meteoric stones.

But after every allowance is made on the above mentioned grounds, it will still remain true that a prevailing metallic character and a high specific gravity, characterize the meteoric minerals when compared with those of our own planet.

Part II.

Chemistry of Meteor-Masses.

The chemical elements thus far known to exist in these bodies, are here arranged in the supposed order of their prevalence.

1. Iron.
2. Nickel.
3. Magnesium.
4. Oxygen.
5. Silicon.
6. Sulphur.
7. Calcium.
8. Aluminium.
9. Chromium.
10. Sodium.
11. Potassium.
12. Cobalt.
13. Carbon.
14. Phosphorus.
15. Chlorine.
16. Manganese.
17. Tin.
18. Copper.
19. Hydrogen.

?20. Titanium.

?21. Arsenic.

The above elements are among those most frequently found entering into the composition of the crust of our globe, (including also its atmosphere.) The individual parallelism in the two cases, may easily be seen from an inspection of the following table. It would be still more striking, if we knew how to make a just allowance for that portion of meteoric matter (the stony) which has fallen in early times, and from the nature of its chemical constitution has either suffered, from atmospheric influences, a total decomposition, or at least become so much altered as no longer to be distinguishable. This arrangement of meteoric elements, like that given above, is constructed from a view of the totality of meteor-masses at present known to be in existence, on the surface of our globe. The terrestrial elements being arranged also as nearly as possible in the order of their abundance, the correspondence they sustain to the meteoric group, will at once be discerned by a reference to the numbers by which one and the same element is preceded on the two lists. The seven elements, among the twenty-eight terrestrial series, not yet detected in meteors, are followed each by a star.

Meteoric Series.	Terrestrial Series.
1. Fe.	1. Ox.
2. Ni.	2. Si.
3. Mg.	3. Al.
4. O.	4. Ca.
5. Si.	5. Mg.
6. S.	6. Fe.
7. Ca.	7. K.
8. Al.	8. Na.
9. Cr.	9. S.
10. Na.	10. C.
11. K.	11. H.
12. Co.	12. Mn.
13. C.	13. Cl.
14. P.	14. F.*
15. Cl.	15. P.
16. Mn.	16. N.*
17. Sn.	17. Ba.*
18. Cu.	18. Zn.*
19. H.	19. Pb.*
?20. Ti.	20. Cu.
? 21. As.	21. As.
	22. Sr.*
	23. Sb.*
	24. Sn.
	25. Cr.
	26. Ti.
	27. Ni.
	28. Co.

It is scarcely to be doubted but that fluorine will soon be detected in meteoric stones, inasmuch as it is a frequent constituent both of mica and of apatite; the former of which minerals, in very minute quantity, has been detected in the Weston stone, while the existence of apatite has been rendered highly probable, if not certain, in the Richmond meteorite. It is easy to conceive that several other terrestrial elements belong to the meteors, which from their volatility, may have been dissipated and lost in our atmosphere, before the masses to which they originally adhered could have reached the ground.

The manner in which the meteoric elements are associated is readily seen, by throwing the mineral species they give rise to, into four groups or orders.

Order First.

1. Iron (Fe, *Native Iron*), and Iron-alloys (Fe^xNi, *Nickeliferous Iron*).

2. Sulphur (S, *Sulphur*), and sulphurets (Fe^6S^7, *Magnetic Iron Pyrites:* $Cr^{2?}S^{3?}$ *Schreibersite*).

3. Carbon (C, *Plumbago*), and Carburets (Fe^xC, *Native Steel:* Fe^xNi^xC. *Nickeliferous Steel*).

4. Phosphuret ($\overline{Fe\ Ni\ Mg}^x\ P$, *Dyslytite*).

?5. Silicet (Fe^xSi ———).

Order Second.

1. Oxides (Fe^2O^3+HO, *Limonite:* Fe^3O^4, *Magnetic Iron;* Cr^2O^3, *Chrome-ore*).

2. Chlorides (Fe Cl: Ni Cl: Ca Cl: Mg Cl: Na Cl).

Order Third.

1. Oxygen acids (SiO^3, *Soluble Silica:* SO^2, *Sulphurous acid*).

Order Fourth.

1. Sulphates ($MgO+SO^3$: $NaO+SO^3$: $NiO+SO^3$: $FeO+SO^3$).

2. Hyposulphites ($NaO+S^2O^2$: $MgO+S^2O^2$).

3. Silicates ($MgO+3SiO^3$ *Chladnite:* Silicates of magnesia, protox. iron, lime, alumina, soda and potassa, *Peridot, Pyroxene, Anorthite, Chantonnite,* and *Garnet*).

?4. Titaniate (—— *Sphenomite*).

?5. Phosphate (*Apatite?*)

The following is, to a short extent, a comparative table of the most abundant chemical compounds, among meteoric and terrestrial minerals.

Meteoric.

1. Iron alloys.
2. Silicates of magnesia, iron, lime, &c.
3. Sulphuret of iron.
4. Oxides of iron and chrome.
5. Chlorides of iron and nickel.

Terrestrial.

1. Silicic acid.
2. Silicates of alumina, potassa, soda and iron, (***Feldspar***, ***Albite*** and *Mica.*)
3. Silicates of alumina, lime, magnesia and iron, (***Hornblende***, ***Pyroxene and Garnet***).
4. Water.
5. Carbonates of lime, magnesia and iron.
6. Sulphurets of iron.
7. Chlorides of sodium, magnesium and calcium.
8. Oxides of iron and manganese.

Part III.

Astropetrology.

Under this general head, the name of which is formed like that of the first department, (astrolithology,) with the exception of the two middle syllables, which are derived from the word πέτρος, a rock, instead of from λίθος, a stone,—the former having reference to an individual species, the latter to a rock-mass, it is intended to embrace information of the same general nature as that, which, in respect to our own planet, is contained under Geology. Astropetrology therefore, will very naturally have two departments of its own: viz. *Descriptive* and *Theoretical Astropetrology.*

1. *Descriptive Astropetrology.*

Under this head, the various rock-masses, or astropetrological species, will be enumerated and arranged. They will form two classes, each having three orders.

CLASS I. METALLIC.

Order 1st, Malleable, homogeneous.	Sec. 1. Pure. - - -		Scriba, N. Y. Walker Co., Ala.
	Sec. 2. Alloyed.	Closely crystalline.	Green Co., Tenn. Texas. Dickson Co., Tenn. Burlington, N. Y.
		Coarsely crystalline.	De Kalb Co., Tenn. Asheville, N. C. Guildford, N. C. Carthage, Tenn.
Order 2d, Malleable, heterogeneous.	Sec. 1. Amygdalo-peridotic,		Krasnojarsk, Siberia.
	Sec. 2. Amygdalo-pyritic,		Lockport(Cambria),N.Y.
	Sec. 3. Pyrito-plumbaginous,		Cocke Co., Tenn.
Order 3d, Brittle.	Sec. 1. Pure, - - -		Bedford Co., Pa. Randolph Co., N. C.
	Sec. 2. Alloyed, - -		Otsego Co., N. Y.

CLASS II. STONY.

Order 1st, Trachytic.	Sec. 1. Peridotic,	Coarse grained,	Weston, Conn. Richmond, Va.
		Fine grained,	Nobleboro, Me. Little Piney, Mo.
	Sec. 2. Pyroxenic, - -		Juvenas, France.
	Sec. 3. Chladnitic, - -		Bishopville, S. C.
	Sec. 4. Carbonaceous, - -		ColdBokkeveld,Af.
Order 2d, Trappean.	Sec. 1. Homogeneous, -		Chantonnay, France.
	Sec. 2. Porphyritic, - -		Renazzo, Italy.
Order 3d, Pumice-like.	- - - - -		Waterville, Me.

Theoretical Astropetrology.—The few facts known under this head, (i. e. which relate to the origin and formation of meteor-masses, the changes they have undergone from the various conditions in which they have been placed, and speculations regarding any traces of life they may contain,) have induced me to postpone any detail of them, to a fuller report on this branch of knowledge, which I hope to submit to the Association at a future period.

PART IV. *Summary of American Meteor-masses.*

CLASS I.

Order 1*st.* Section 1st.

1. Scriba, (Oswego,) N. Y. Found 1834. Described 1841. SHEPARD. Weight 8 lbs.

2. Walker Co., Ala. Found 1832. Described 1845. Troost. Weight 165 lbs.

Section 2d. *Closely Crystalline.*

3. Green Co., Tenn. Found 1842. Described 1845. Troost. Weight 20 lbs.

4. Claiborne, Ala. Found 1834. Described 1838. Jackson. Weight about 40 lbs.

5. Livingston Co., Ky. Described 1846. Troost.

6. Dickson Co., Tenn. Fell July or August, 1835. Described 1845. Troost. Weight 9 lbs.

7. Texas, (Red River.) Found 1808. Described by Gibbs and Silliman, Sen. Weight 1700 lbs.

8. Burlington, N. Y. Found 1819. Described 1844. Silliman, Jr. Weight about 150 lbs.

Coarsely Crystalline.

9. DeKalb Co., Tenn. Described 1845. Troost. Weight 36 lbs.

10. Asheville, N. C. Described 1839. Shepard. Weight about 30 lbs.

11. Guilford, N. C. Found 1820. Described 1841. Shepard. Weight 28 lbs.

12. Carthage, Tenn. Described 1846. Troost. Weight 280 lbs.

13. Jackson Co., Tenn. Described 1846. Troost.

Order 2d. Section 2d.

14. Lockport, (Cambria,) N. Y. Found 1818. Described 1845. Silliman, Jr. Weight 36 lbs.

Section 3d.

15. Cocke Co., Tenn. Described 1840. Troost. Weight about 2000 lbs.

Order 3d. Section 1st.

16. Randolph Co., N. C. Found 1822. Described 1846. Shepard. Weight about 2 lbs.

17. Bedford Co., Pa. Found 1828. Described 1846. Shepard. Weight a few ounces.

Section 2d.

18. Otsego Co., N. Y. Found 1845. Described 1846. Shepard. Weight 276 grs.

APPENDIX TO CLASS I.

19. Buncombe Co., N. C. Found 1845. Described 1846. SHEPARD. Weight 27 lbs.

20. Grayson Co., Va. J. B. ROGERS.

21. Roanoake Co., Va. W. B. ROGERS.

22. White Mountains, (near Franconia,) N. H. Described 1846. SHEPARD. Weight about 20 lbs.

CLASS II. *Order* 1*st.* Section 1st.

Coarse Grained.

1. Weston, Conn. Fell Dec. 14, 1807. Described by SILLIMAN, Sen., and KINGSLEY. Weight about 300 lbs.

2. Richmond, Va. Fell June 4, 1828. Described by SHEPARD. Weight 4 lbs.

Fine Grained.

3. Nobleboro, Me. Fell Aug. 7, 1823. Described by CLEAVELAND and WEBSTER. Weight about 5 lbs.

4. Nanjemoy, Md. Fell Feb. 10, 1825. Described by CARVER and CHILTON. Weight 16 lbs.

5. Sumner Co., Tenn. Fell May 9, 1827. Described by SEYBERT. Weight 11 lbs.

6. Forsyth, Ga. Fell May 8, 1829. Described by SILLIMAN, Sen., and SHEPARD. Weight about 36 lbs.

7. Little Piney, Mo. Fell Feb. 13, 1839. Described by HERRICK and SHEPARD. Weight about 50 lbs.

Section 2d.

8. Bishopville, S. C. Fell March, 1843. Described by SHEPARD. Weight 13 lbs.

Order 3*d.*

9. Waterville, Me. Fell Sept., 1826. Described by SHEPARD. Weight about 3 ounces.

APPENDIX TO CLASS II.

10. At Sea, lat. 30° 58′ N., lon. 70° 25′ W. Fell June 20, 1809. Described by GATEWOOD. Weight 6 ounces.

11. Caswell Co., N. C. Fell Jan. 7, 1810. Described by MADISON. Weight 3 lbs.

The descriptions of the foregoing American localities, so far as they have not heretofore been published, will conclude the present report; and will appear in the next number of this Journal.

ART. XXXVI.—*Catalogue of Shells Inhabiting Tampa Bay and other parts of the Florida Coast;* by T. A. CONRAD.

Bivalves.

Amphidesma variegata, Lam.; rare. Mullet Key of Tampa Bay.—*A. radiata*, Say; found alive on Mullet Key.—*A. orbiculata*, Say; rare. Mullet Key.—*A. equalis*,* Say; common. Mullet Key.

Arca zebra, dredged up alive in Tampa Bay.

Artemis elegans,* Conrad; rare. Mullet Key.—*A. concentrica*, Lam.; common. This and the preceding species have probably been regarded as identical, but in every stage of growth there is a uniform and marked difference; the former species being more orbicular and convex, and having much more remote and distinct grooves, a character as obvious on the young shells as on the adults. It is much the rarest of the two species, and occurs fossil in the Miocene of North Carolina.

Anomia ephippium,* Lin.; common. Keys of Tampa Bay.

Arca scapha? common. Mullet Key.—*A. incongrua*, Say; rare. Mullet Key.—*A. ponderosa*, Say; rare. Mullet Key.

Avicula ——; rare. Egmont Key, Tampa Bay.

Astarte lunulata,* Con.; common. Egmont Key, Tampa Bay. —*A. flabella;* rare. Egmont Key, Tampa Bay.

Cardium citrinum, Wood; common. Mullet Key.—*C. isocardia*, Lam.; common. Mullet Key.—*C. magnum*, Born.; common. Mullet Key.—*C. bullatum*, Lam.; rare. Mullet Key. —*C. Mortoni*, Con. Very abundant on the shores of Tampa Bay, and I do not remember finding it on any of the Keys. The allied species, *C. citrinum*, on the contrary, occurs only on the Keys. The former is readily distinguished by its far less size, want of polish, and the almost invariable purple spots which mark the interior of *C. Mortoni*. The latter lives as far north as Massachusetts, but the *citrinum* is confined to the southern coast.

Carditamera floridana, Con. Common in Tampa Bay frequenting oyster beds, (*Cypricardia nodulosa*, Mighels.) I did not find it on the Keys of Tampa. It also occurs on the shores of Key West and of Lignum Vitæ Key, East Florida. There are several Miocene species of this genus in Virginia, Maryland,

and North Carolina. It is very distinct from either *Cardita* or *Cypricardia.*

*Cardita tridentata,** Say; rare. Egmont Key.

*Chama arcinella,** Lam.; abundant on north end of Mullet Key.

Cytherea gigantea, Lam. Abundant. Mullet Key.—*C. maculata,* Lam.; rare. Mullet Key.

Corbula limatula, Con. Deep water, between Tampa Bay and Pensacola.

Cyrena carolinensis, Bosc. Head of Tampa Bay.—*C. Floridana,* Con. Common on the bay shores. It prefers salt water, whilst the former species invariably confines itself to the scarcely saline estuaries of rivers.

Donax variabilis, Say. The most abundant of all the bivalves of Florida, burrowing in the sand. As the surf rolls over them they come to the surface, burying themselves instantly as the waves recede.—*D.* ——. A small ovate species. Coast of Florida near St. Joseph's Bay.—*D.* ——. Longer than *D. variabilis,* with an arched base. Egmont Bay.

Lucina nassula, Con. Egmont Key. Nearly allied to the Miocene *L. cribraria,* Say.—*L. pennsylvanica,* Lam.; rare. Mullet Key.—*L. squamosa,** Lam.; rare. Mullet Key.—*L. tigrina,* Lam.; rare. Mullet Key.—*L. floridana,* Con.; very abundant. Mullet Key and bay shores. This is the analogue of the Miocene *L. anodonta,* Say. It is never so thick and variable in form nor so large as many of the fossil species.—*L. edentula,* Lam.; rare. Mullet Key.—*L. trisulcata,* Con.; rare. Egmont Key.

Mactra ovalis? Common. Egmont and Mullet Keys.—*M. lateralis,** Say. Abundant. Egmont Key.—*M. fragilis,* Lam. Common. Bay Shores.

Modiola demissa, Dill. Abundant. Bay shores.—*M. lateralis,* Say. Bay shores.—*M. papyria,* Con. Bay shores.—*M. americana,* (*M. tulipa,* Lam.) St. Joseph's Bay.

Mytilus hamatus, Say. Common. Manatee river, Tampa. —*M. cubitus,* Say. Common. Manatee river, Tampa.

Meleagrina ——. Rare. Egmont Key. A small species with profoundly elongated scales.

*Nucula acuta,** Con. Dredged up in deep water in the Gulf of Mexico.—*N. eborea,* Con. Rare. Egmont Key.

Ostrea virginiana, Gmel. Abundant in Tampa Bay.

Osteodesma hyalina, Con. Abundant in Tampa Bay and lives as far north as Massachusetts.

Periploma inequivalvis, Lam. Rare. Bay shores.

Pecten concentricus, Say. Common. Bay shores.—*P. dislocatus*, Say. Common. Mullet Key.

Pinna ——. Common. Mullet Key and Tampa Bay. It has distant series of long, thick, remote, tubular spines. I cannot refer to any of the descriptions or figures I have seen.—*P. floridana*, Con. Mullet Key. Rarely entire.

Plicatula ramosa, Lam. Common. Egmont Key.

Solen ensis, Lin. This is the variety *minor* which lives as far north as the Carolinas. The *major* is limited to the coast north of this latitude. This fact has led me to believe that two species are designated by the name of *ensis*.

Solecurtus fragilis, Van. Common. Egmont Bay. I think this species is distinct from *S. fragilis*, but in deference to the opinion of an eminent conchologist I have classed it as a variety of that species.

Tellina punicea, Lin. Mullet Key.—*T. acuta*, Wood. Rare. Mullet Key.—*T. lateralis*, Say. Common. Bay shores. This shell also inhabits St. John's river, East Florida, and is said to inhabit Africa and California.—*T.* ——. A thin sub-triangular species very common in Tampa Bay.—*T.* ——. Two or three undetermined species. Key shores.

Venus cancellata, Lam. Next to *Donax variabilis* the most abundant shell on Mullet Key.—*V. punctulata*, Valen. Egmont Key.—*V. Mortoni*, Con. Abundant in Tampa Bay, a gigantic species found also in Charleston harbor. The young shell is covered with elevated laminæ and generally has angulated markings, resembling those of *V. notata*. One specimen of considerable size has distinct distant broad fulvous radii. The species I believe never has a purple spot in the interior so general in specimens of *V. mercenaria*. The size is generally about six and a quarter inches in length and five and a half inches in height, and the weight of the shell without the animal about four pounds. It resembles the fossil *V. permagna*, Con., but that species has much more robust concentric lines or ridges, and attains a rather larger size.—*V. cuneimeris*, Con. Bay shores; common.

Univalves.

Actæon floridanus, Con. Bay shores.

Bulla succinea, Con. Common. Bay shores.—*B.* ——. Common. Mullet Key.

Bullina canaliculata, Say. Bay shores.

Cancellaria cancellata, Lam. Rare. Mullet Key.

Cerithium protextum, Con. St. Joseph's Bay.—*C. septemstriatum*, Say. Lignum Vitæ Key, E. Florida; Key West.—*C. eriense*, Kiener, (*C. nigrescens ?* Minke.) Common in Manatee river. It is a singular error of Kiener's to give Lake Erie as the habitat of a species of *Cerithium*. It is found on the Atlantic Keys of Florida.—*C. dislocatum*, Say. St. Josephs Bay.—*C.* ——. Two undetermined species. Egmont Key.

Crepidula fornicata, Lam. Common. Mullet Key.—*C. maculosa*, Con. Common. Mullet Key.—*C. aculeata*, Lam. Common. Inhabits Oyster beds in Tampa Bay.—*C. unguiformis*, Lam., (*plana*, Say.) Key shores.

Cypræa pediculus, Very rare. Egmont Key.

Cassis sulcosa, Lam. Rare. Mullet Key.

Columbella avara, Say. Bay shores.—*C.* ——. Bay shores.

Conus ——. Bay shores.

Dentalium eboreum, Con. Southern coast of Florida.—*D. coarctatum*,* Lam., (*D. gadus*, Sow.) A single living specimen came up on the lead in deep water.

Fulgur perversus, Lam. Common. Bay shores.—*F. pyruloides*, Say. Common. Bay shores. The genus *Fulgur* of Montford is identical with *Pyrula*, Lam., and his priority by date of many years anterior to Lamarck's *An. sans Vert.*, though the name of *Pyrula* is generally adopted by conchologists. It would be useful to science, if some uniform rule were established with regard to certain authors, and either all Montford's genera rejected, or acknowledged where his names have priority in date of publication. *Pyrula ficus* and its congeners have been separated by Sowerby from the other members of the genus *Pyrula*, of Lamarck, retaining the name, whilst Rousseau has subsequently named it *Ficus*. The former would be preferable, as having long been in use, and not like the latter preoccupied in Botany, if *Fulgur* should be retained. If not retained, then the original name of *Pyrula* will revert to *P. canaliculata* and its congeners. Rousseau has described the animal of *Pyrula ficus*, and shown that it has more affinity for *Harpa* and *Dolium*, than for other species of Lamarck's genus *Pyrula*. In exterior characters and general appearance, the animal of Say's *P. papyracea* bears no resemblance to that of *Fulgur perversus* and its congeners. It is not operculated, and spreads a very singular mantle over nearly the whole shell. The mode of excluding their young in a spiral string of chambers is peculiar to the *P. perversa, pyruloides, carica* and *canaliculata*, which constitutes Montford's genus *Fulgur*.

Fasciolaria trapezium, Lam. Common. Bay shores.—*F. distans*, Lam. Common. Mullet Key and Bay shores.—*F. tulipa*, Lam. Common. Mullet Key and Bay shores.

Fusus perrugatus, Con. Manatee river. Fusiform, with remote longitudinal ribs, and large prominent revolving lines alternated with a fine line; whorls longitudinally rugose, upper half flat and oblique; aperture rather more than half the length of the shell, purple within; labrum striate; color of the exterior cinereous. Proportionally wider than *F. cinereus*, with fewer and larger ribs and lines.

Fissurella, ——. Key shores.

Littorina littorea, Say. Bay shores.—*L.* (*Phasianella*) *angulifera*, Lam. Abundant on grass, bushes and trees on the Bay shores.

Murex ostrearum, Con. Mullet Key.—*M. cellulosa*, Con. Inhabits oyster beds in Tampa Bay.—*M. tampaensis*, Con. Inhabits oyster beds in Tampa Bay.

Marginella conoidalis, Kiener. Abundant. Bay shores.—*M. succinea*, Con. Rare. Bay shores.—*M. albilabris*, Con. Rare. Bay shores.

Monodonta, ——. Tampa Bay. Common.

Melampus bidentatus, Say. Common. Bay shores.

Melongena corona (*Fusus*) Lam. Common. Bay shores. This shell has all the characters of the genus *Melongena*.

*Natica duplicata** ? Say. Mullet Key and Bay shores.—*N. canrena*,* Lam. Very rare. Egmont Key.

Neretina (*Theodoxus*) *reclinata*, Say. Manatee and Hillsborough rivers, Tampa; Mobile, Alabama.

Oliva litterata,* Lam. Common. Key shores, living a few inches deep in the sand, and readily found by its trail on the surface.—*O. mutica*, Lam. St. Joseph's Bay. Its habits are the same with the preceding.—*O. anazores.* Southern coast of Florida.

Ovulum aciculare, Lam. Very rare. Tampa Bay.

Patella, ——.

Pleurotoma, a small black tuberculated species. Tampa Bay. —*P.* ——. Small; longitudinally ribbed; pale. Tampa Bay.

Pollia tincta, Con. Inhabits a sand bar at the entrance of Manatee river.—*P. cancellaria*, Con. Ship Island.

Pyrula papyracea, Say, (genus *Ficus*, Rousseau.) Mullet Key. Common.

Pyramidella alveata, Con. Rare. Bay shores.

Pyrena scalariformis, Say. Common. Inhabits pools on the Keys.

Ranella caudata, Say. Rare. Mullet Key.

Strombus pugillus. Common. Mullet Key.

Scalaria. ——. Rare. Bay shore.

Triton lineolatum, Con. Bay shores.—*Truncatella*, ——. Bay shores.

Turbo castaneus. Common. Mullet Key.

Trochus tampaensis, Con. Bay shores.

Voluta Junonia. Very rare. Egmont Key.

Vermetus lumbricalis, Lam. Mantee river.

Multivalves.

Balanus ovularis, Lam.

Coronula testudinalis, Sow. On the green turtle in Tampa Bay.

Pholas costata. Rare. Mullet Key.

Teredo navalis, Lin. Common. Tampa Bay.

In the above catalogue the Miocene species are indicated by an asterisk.

Although the proportion of univalves and bivalves is nearly equal as to species, yet the bivalves far outnumber in quantity the former; and this is the case also in the Tertiary deposits. I had remarked this fact years ago, and alluded to it in my publication on the Miocene fossils. It holds good on every part of the coast I have visited, but in the bays, lagoons and estuaries I found the proportion of univalves much larger than on the sea beach.

The land shells about Tampa are *Polygyra plicata*, *P. septemvolva*, *Glandina truncata*, and a species of *Pupa*. On Lignum Vitæ Key, E. Florida, I found the same *Polygyræ*, with *Achatina fasciata* and *Succinea campestris*.

ART. XXXVII.—*Descriptions of new species of Organic Remains from the Upper Eocene Limestone of Tampa Bay;* by T. A. CONRAD.

BULIMUS.

Bulimus floridanus.—Ovate-acute, narrow; whorls 6? finely striated obliquely; spine elevated, longer than the aperture, whorls convex; body whorls with an impressed line which margins the suture; aperture narrow, subovate, labrum and labium reflected; base with a deep channel behind the reflected labium.

This is the only fossil land shell yet discovered in an American tertiary formation. Very few species of this genus exist in North America, and they are all limited to the southern portion of the Union. The B. floridanus is very dissimilar to any of these, being much less ventricose and having more affinity with the group constituting the genus Partula.

BULLA.

Bulla petrosa.—Oval, destitute of striæ? summit oblique.

Ballast Point, Tampa Bay. Rare.

NUMMULITES.

Nummulites floridanus.—Discoidal, diameter through the middle of moderate width; volutions about 3 in number; surface with minute revolving lines.

Occurs with the preceding. Abundant. It belongs to the subgenus Assilina, D'Orbigny.

Cristellaria rotella.—Discoidal, with impressed radii; middle of the anterior side with a sudden depression. Abundant. Occurs with the preceding.

This small fossil can be distinctly seen without a magnifier, and some specimens are large enough to shew the impressed lines. It closely resembles a species of the Paris Eocene. By breaking the rock into small fragments, specimens will fall out entire.

VENUS.

Venus penita.—Cuneiform, concentrically striated, the lines strong anteriorly, posteriorly less distinct, posterior side produced, compressed, extremity angulated; ligament margin very oblique and straight from umbo to extremity; summits very prominent; cardinal teeth very robust; basal margin slightly arched posteriorly; inner margin crenulated.

Ballast Point, Tampa Bay.

Little of the shell remains, which exhibits those radiating furrows common to all the chalky specimens of the genus in a fossil state. A cast of the hinge shews the form of the teeth, and an impression in the rock copies the exterior characters of the shell.

Venus floridana.—Triangular, with concentric distant ribs;

umbo broad, elevated; ligament margin very oblique, straight; valves slightly flattened or compressed posteriorly, extremity angulated.

Occurs with the preceding.

Plagiostoma?

An indeterminate species with numerous approximate somewhat squamose radiating undulated striæ.

Occurs with the preceding.

NUCULA.

Nucula tellinula.—Longitudinally ovate, with central beaks;

anterior end narrow, slightly truncated at the extremity, anterior dorsal margin straight and very oblique.

Occurs with the preceding.

CYTHEREA.

Cytherea floridana.—Oval, inequilateral, rounded at the ends;

ligament margin slightly curved; basal margin rounded.

Occurs with the preceding.

This seems to have been a smooth and polished species, but none of the shell remains.

BALANUS.

Balanus humilis.—Suboval, not elevated; aperture large,

somewhat diamond shaped; valves with rather fine longitudinal approximate sulci.

Hillsborough Falls.

SCIENTIFIC INTELLIGENCE.

I. Chemistry.

1. *Atoms and Ray Vibrations.*—In the London and Edinburgh Philosophical Magazine for May, 1846, we find an article by Professor Faraday, entitled, "Thoughts on Ray Vibrations," in which, adopting Boscovich's idea of matter, (that it consists altogether of "forces,") he sets aside the old hypothesis of an Ether producing heat and light by its vibrations, and offers in its stead, the *forces*, of which the atom, or ultimate particle, is composed. He considers all effects of attraction and repulsion as happening in certain "lines of force," established between the atoms.

It is somewhat curious that so abstract an opinion should have originated almost simultaneously on both sides the Atlantic; for we find it distinctly announced by Mr. J. D. Whelpley, as a consequent of the same views of matter, in the number of this Journal for April, 1845,* a year previous to the publication of Professor Faraday's article. The same appeared also in a paper by the same gentleman, read before the American Association of Geologists and Naturalists, at New Haven, Conn., April, 1845.† In an abstract of this paper published in a pamphlet of the proceedings of that meeting, the existence of a light-producing ether is controverted, on the ground that the *forces* of the atoms of matter, (which compose it) are *substantially* extended through all space, and constitute thereby the true ether, whose vibrations are light and radiant heat.

Professor Faraday's argument is curious; and as this new hypothesis is like to excite much attention, we give the whole of it in a condensed form.

1. The question is, whether the vibrations of light may not occur in certain "lines of force," which "connect" particles and masses together. If we admit these "connections," there is no occasion for the hypothesis of an ether.

2. Matter should be regarded as composed not of dead particles, but of active centers of forces. These centers are mathematical points. The atoms are extensions of forces, from these points, throughout all space.

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* American Journal of Science and Arts, for April, 1845, xlviii, 352. Article on "The Idea of an Atom," by James D. Whelpley.

† See Report of the Proceedings, in which there is an abstract of the paper above mentioned.

3. All the atoms are "tied together," no matter how remote they be, by lines of mutual force, along which the vibrations proceed, and in which attractions operate.

4. The imaginary nuclei, or "little independent particles," of the old hypothesis are of no use in explaining gravitation, or any other of the more extended powers of matter; all the effects which we witness are due solely to the *forces*, and not to any *real* nuclei; we may therefore dismiss them as unnecessary, together with the æther.

5. "I do not perceive in any part of space any thing but forces, and the lines in which they are exerted."

6. "Mossoti has shown that gravitation, aggregation, electric force, and electro-chemical action, may all have one common connection, or origin; and so, in their actions at a distance, have they not in common that infinite scope which some of these actions are known to possess."

7. "In the view now set forth, the forces of the atomic centers are supposed to pervade (and make) all bodies and to penetrate all space."

8. The æther was supposed to do the same, but was divided by certain centers, from which it acted: These centers are now taken to be the same with those of the material atoms; and thus the æther vanishes.*

Mr. Whelpley begins his argument with the assumption, that the true idea of an atom *must* be attained by a simple induction from the properties of the mass, to the properties of the particle. That by this method alone can such an idea be attained. Thus, (1.) if every mass gravitates, every atom gravitates. (2.) If every mass is in electric relation to all other masses, every atom is in the same relation. (4.) If masses are elastic and expansible in change of temperature, atoms are the same. (4.) If masses become gaseous, it is the atom itself which suffers this increase of repulsion. (5.) If masses chemically combined interpenetrate and lose their proper characteristics, atoms do the same. (6.) If masses are always bipolar, or multipolar, in their relations to other masses, atoms are the same. (7.) Finally, if all the properties of a mass may be reduced to certain repulsions and attractions, acting from and about certain centers, (as it is certain they can), the atom itself *must* be conceived of, as composed in like manner of certain forces acting in the same manner.

The effect of this method of induction is to establish the idea of an atom upon natural and philosophical grounds. Thus, by the old axiom, "that a thing cannot act where it is not," which is a known condition

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* Abstract of an article by Prof. Faraday, entitled, "Thoughts on Ray Vibrations." London, Edinburgh and Dublin Philosophical Magazine, and Journal of Science, for May, 1846, (page 345–50.)

of the *masses* of matter, we infer that the *atoms* also, cannot act where they are not; and that, in very truth, they are every where, (as Faraday assumes,) but diversely in different places. Thus, as the masses are gravitantly and electrically every where, excepting within certain small limits about their centers; so, *within these small limits*, they are present to each other in a different manner, namely, chemically, and mechanically.—The atoms being universally present in space through their electric and gravitant relation, they do really fill all space and constitute a true æther capable of propagating the motions of heat and light. *The small limits within and without which the powers operate, are the imaginary spheroidal limits of the 'nucleus' or lesser sphere of the atom.*

By this new atomic theory, the chemist unburthens himself of a great variety of hypotheses;—such as that of "*latent heat*," "specific heat,"* "visible dead molecules,"† "interstellary æther,"‡ "caloric," "electric fluids,"§ with all the hard drawn lines which separate the parts and powers of matter from each other, and prevent the conception of it as a whole.

It reduces every thing to *forces*. Reasoning from the always electrified and gravitant mass, to its least particle, it finds that particle in relation, through a line of gravity, (which is also a line of electric induction,) with every other least particle in the universe. The number of these lines being truly infinite, the whole of space is occupied by them. The substance in which they are generated is the ancient First Matter, or Potential, of which the human understanding forms an idea to itself, and calls it *matter*, or, (dynamically) *force*. This first matter always appears as *positive and negative*, resolving itself into oppo-

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* Proceedings of the sixth annual meeting of the Assoc. of Amer. Geol. and Nat., held in New Haven, Conn., April, 1845, (pages 17–22, of the pamphlet report.)

† Ibid., page 20.

‡ "If the central 'nucleus' contracts by *pulses*, or minute vibrations, these must be radiated from it in the manner of *waves;* traversing space, like the radiant *pulses* of light. But why are not these 'waves,' the same with those 'pulses?'—Assuming their identity, there would then be no place for an hypothesis of a peculiar æther of light and heat, since the atoms do of themselves constitute an æther;—for they pervade all space." *Idea of an Atom suggested by the phenomena of weight and temperature;* by James D. Whelpley, Amer. Jour. of Science for April, 1845.

§ Ibid p. 21. Every atom in the solid condition is regarded as having its *forces* P, N, resolved into crystallogenic axes ($p\ n, p'\ n', p''\ n'',$) ;—each of these is liable to a disturbance in the distribution of the forces p and n; but by the universal law of equilibriums, if one is diminished the other is just as much increased; then add, that if p in one atom is coincident with n in another, they will always be exactly equal in intensity,—and it follows that the disturbance will propagate itself in the manner of electric pulses. (See also Amer. Jour. of Sci., April, 1845, xlviii, 364.)

sites. The theorist shows, that gravitation itself is a consequence of such a resolution: and that two atoms so composed will necessarily gravitate. (See Art. in this Journal for April, 1845, and Report of Assoc. of Americ. Geol. and Nat. for the same year.)

By this induction from the mass to the atom, the atom is made an Individual, having a specific *size*, which is the variable limit of its *molecular* force; and an *infinitude*, which is the extension of its gravitant and electric force:—It preserves this individuality, while it extends through, and interpenetrates with every other atom. It has also two kinds of polarity, the remote and the near; and also an antipolar, or unresolved state, when its two forces are coincident about the same center,—which is the gaseous condition. Liquidity is assumed to be an intermediate state between solid and aeriform; and solidity to be the state of ultimate polarity, when all its force is resolved, and divided into polar axes, ('crystallogenic axes of *Dana*.')

It will be seen, on a careful examination, that a theory of matter founded on such a method of induction admits of the exactest mathematical applications; and that it possesses a simplicity which adapts it alike to all phenomena.

Mr. Whelpley, in the following paragraph expresses definitely the views above alluded to and also others of equal importance with reference to the nature of heat. (Proceed. Assoc. of Americ. Geol. and Nat. 1845, p. 17.)

"When a body is heated it expands:—Hence,—*rise of temperature is the same with an expansion of the molecular spheres of the atoms.* If the motions of heat and light can be otherwise explained, the notion of an ether distinct from gravitant matter, may be set aside; but all the properties of a mass are reducible to *forces*, causing motion and rest: all the properties of an atom are, therefore, its forces, or powers. It follows that an atom can be known only by these forces; and because the *force* of gravity is every where present, in that sense, the gravitant atom is itself 'every where present:' and the same is true of its magnetic and electric force. *The extended atmosphere* of an atom is, therefore, its proper ether, through which it radiates pulses of heat and light, and is electrically, magnetically, and attractively, present in the whole of space.*

"Some substances, such as the metals, being more susceptible than others to change of temperature, the same is true of their atoms. The impenetrable nucleus, or molecule, of an atom, may be either greater or less. When a *cold* nucleus touches a *hot* one, the greater contracts, and the lesser expands; according to a law of *equilibrium of tempera-*

* Sanscrit, *atma*, breath, omnipresent power, first principle.

ture; which necessitates, *that a molecule, or repellent nucleus, shall be of equal temperature with those that are in contact with it.* And the reason of this law is axiomatic; for that all motion is attended with the loss or attainment of an equilibrium. *All forces of action and reaction, attraction and repulsion, develope each other, and are therefore equal.*

"When two nuclei, the same in kind, but differing in size, are brought in contact, they will presently divide the difference, both attaining the mean diameter, and the mean intensity of repulsion; for it is necessary to admit, *that the intensities of the spheres of temperatures vary inversely as the cubes of their diameters.* But if they be of different species, (e. g. gold and iron,) one will contract, or expand, more than the other. Thus, gold, under the same influences, contracts, or cools, more than iron; and this difference expresses what is inconveniently termed, their 'specific heat;' meaning their 'relative degrees of *in*susceptibility.' It would be more convenient to speak of their *susceptibility.*"

It is necessary to caution the chemist, against confounding the 'nuclei' of this theory, with the "hard particles" of the Epicurean, or Wollastonian, hypothesis: they are not 'hard, visible, particles,' but mere variable, invisible, *limits; in* which the repellent, and cohesive, forces are developed.

2. *On a simple method of protecting from Lightning, Buildings with Metallic Roofs;* by Prof. Henry, (from Proceedings of American Phil. Soc., June 20, 1845.)—On the principle of electrical induction, houses thus covered are evidently more liable to be struck than those furnished either with shingle or tile. Fortunately, however, they admit of very simple means of perfect protection. It is evident, from well established principles of electrical action, that if the outside of a house were encased entirely in a coating of metal, the most violent discharge which might fall upon it from the clouds would pass silently to the earth without damaging the house, or endangering the inmates. It is also evident, that if the house be merely covered with a roof of metal, without projecting chimneys, and this roof were put in metallic connection with the ground, the building would be perfectly protected. To make a protection, therefore, of this kind, the Professor advises that the metallic roof be placed in connection with the ground by means of the tin or copper gutters which serve to lead the water from the roof to the earth. For this purpose, it is sufficient to solder to the lower end of the gutter a riband of sheet copper, two or three inches wide, surrounding it with charcoal, and continuing it out from the house until it terminates in moist ground. The upper ends of these gutters are generally soldered to the roof; but if they are not in metallic connection, the two should be joined by a slip of sheet copper. The only part of the house unprotected by this arrangement will be the chimneys; and in order to

secure these, it will only be necessary to erect a short rod against the chimney, soldered at its lower end to the metal of the roof, and extending fifteen or twenty inches above the top of the flue.

Considerable discussion in late years has taken place in reference to the transmission of electricity along a conductor; whether it passes through the whole capacity of the rod, or is principally confined to the surface. From a series of experiments presented to the American Philosophical Society, by Professor Henry, on this subject, it appears that the electrical discharge passes, or tends to pass, principally at the surface; and as an ordinary sized house is commonly furnished with from two to four perpendicular gutters (generally two in front and two in the rear,) the surface of these will be sufficient to conduct, silently, the most violent discharge which may fall from the clouds.

3. *Electric Conduction;* by C. G. Page, (in a letter to the Editors.)—Since my last communication on *Electric Conduction, &c.* published in your Journal for September, 1846, finding that the merit of original observation of the inductive action of atmospheric electricity upon extended conductors, has been by some attributed to me, I take early opportunity through your indulgence to correct any such impression. Your readers by a careful perusal of the paper, will perceive that I have introduced the subject, rather incidentally, to prove the sensitiveness of the galvanoscope used in the experiments, and that a sufficient disclaimer will be found in a concluding passage, as follows, viz: "During heavy storms a flash of lightning twenty miles distant from the wires of Morse's telegraph, will induce electricity in the wires sufficient to operate the magnets and work the telegraph, sometimes recording several signals," an occurrence which has been noticed occasionally, since the erection of the telegraph in the early part of 1844.

The merit of prior and original investigation with reference to these phenomena, belongs to Prof. Henry; the results of whose observations were published sometime since in the Transactions of the American Philosophical Society. The only novelty as far as induction is concerned in the observations made by myself, is that extraordinary kind of disturbance which the needle incurs, under which it will frequently move, not as if by sudden impulse, but rather gradually through an arc, sometimes of 10°, and there remain for sometime, and then return to what may be called its standard position, viz. that which is due *solely* to the influence of the galvanic current. It would appear that these changes are due not to *sudden* discharges of atmospheric electricity, but to the passage of clouds or masses of air in different electrical states over or near the building. The question then arises, does the roof of the building collect and transmit sufficient electricity to deflect the needle to this extent, or is it due to some other influence. It has occurred to me that a charged cloud or stratum of air may by simple induction, without transference, so affect the conductors as to produce this disturbance. If so, a new field for investigation will be opened. At present, circumstances will not allow of any observations in the night, and pressing official duties forbid any thing more than casual observations during the day. I may mention in conclusion, that at present, the usual daily range of the galvanoscope is 20°, that is, from 8 A. M. to 6 P. M. At 8 A. M. the deflection is from 43° to 45°, and at 6 P. M. 23° to 25°.

4. *On the production of a new organic alkali;* by G. FOWNES, (Philosophical Transactions, 1845, 2d part, p. 263.)—When starch is distilled with diluted sulphuric acid, a small quantity of an oily matter passes over, accompanied by formic acid. This oil is obtained in larger quantity from bran; one pound of this, distilled with half a pound of sulphuric acid and three pounds of water, yielded a drachm of it. When pure, it is a colorless, oily fluid, which becomes brown by exposure to the air; it is slightly soluble in water, but easily in alcohol. Its odor resembles that of a mixture of oil of bitter almonds, and of cassia. Its sp. gr. is 1·168; boils at 323° F., and distills unaltered. Cold sulphuric acid dissolves it, giving a magnificent purple tint; nitric acid oxydizes it, forming oxalic acid.

Mr. Fownes has given to this substance the name of *furfurol*, (from *furfur*, bran,) and expresses its composition by the formula, $C_{15}H_6O_6$.

When placed in contact with five or six volumes of liquor ammoniæ, they slowly combine, and in few hours form a solid mass, which consists of a yellowish-white, flocculent crystalline matter, insoluble in water, but soluble in alcohol. Repeated analyses give for this substance the formula $C_{15}H_6NO_3$; it is formed from the oil by the addition of one equivalent of ammonia and the abstraction of three equivalents of water. This substance has all the properties of an *amide*. Acid decomposes it immediately, forming a salt of ammonia and setting free the oil. The same decomposition takes place slowly with water, the substance combining with the elements of the liquid, and regenerating ammonia and furfurol. The action of alkalies is however very peculiar. A boiling dilute solution of potash readily dissolves it without the evolution of ammonia, and on cooling, deposits brilliant silky needles of a new substance. This has precisely the same composition in a hundred parts as the amide from which it was derived, but differs from it entirely in its properties. It is a strong organic base, neutralizing acids, and forming definite crystallizable salts.

The analysis of its salts gives the formula $C_{30}H_{12}N_2O_6$, which is just double that of the amide. This substance is the only product of the reaction, the whole of the amide being obtained in the form of the new alkaloid. It is soluble in boiling water, but crystallizes on cooling, and dissolves very readily in alcohol. These solutions have a strong alkaline reaction; their taste is slightly bitter, but that of the salts is powerfully so. Its combinations with acids are beautifully crystalline. The hydrochlorate forms fine acicular crystals resembling those of the corresponding morphine compound. Its formula is $C_{30}H_{12}N_2O_6$, Cl H+2HO. It is quite neutral in its reactions. With bichlorid of platinum it forms a sparingly soluble double salt, which is composed of one equiv. of each of its constituents. Mr. Fownes has described a large number of other salts of this new base, which he denominates *furfuroline*. He observes that they are precipitated neither by solutions of peroxyd of iron, oxyds of copper or silver, lime or baryta.

This substance is very remarkable in several particulars; the manner in which it is derived from an amide, is peculiar and interesting. Caustic alkalies generally decompose this class of compounds, evolving ammonia, but we see in this instance only a re-arrangement of its elements, producing a new and peculiar compound. Fownes has also shown that *hydrobenzamide*, a product of the action of ammonia on oil of bitter almonds, is slowly changed by the same process, into a new alkaloid which he has named *benzoline*. In this case the atomic weight remains unaltered. The statement relative to the behavior of the salts of *furfuroline* with those of other bases, is worthy of especial notice. That a hydrochlorate or sulphate, should not precipitate salts of silver or baryta, is an anomaly in the history of the alkaloids, and finds an analogy, only in the peculiar nature of the salts of ethyle and methyle, and the no less curious reactions of the analogous compounds of oxyd of chromium. The nature of the affinities which unite the elements in such compounds, presents a highly interesting subject for study and speculation.

The artificial formation of such compounds must be regarded as one of the greatest achievements of organic chemistry. The result of such discoveries does not however furnish us any key to the nature of the vital forces, but only demonstrates more clearly the fact that these compounds, although generated in organized structures, are the results of chemical, and not of vital action. All the products of organic life which the art of the chemist has as yet succeeded in artificially forming, are but the secreted or excreted products of the organism, and chemical affinities alone have produced them. These affinities are perhaps enabled to act with a peculiar power in the living structure, only so far as the organic forces may present the elements in such conditions as are peculiarly favorable to their action.

Many of the results which have rewarded the investigations of the organic chemist, are highly interesting and curious. Thus by the oxydation of salicine, the bitter principle of the willow, we obtain a peculiar oil which is identical with the fragrant essence of the *Spirea ulmaria*. The oxydation of this oil has afforded us a new acid, the salicylic, which is very like benzoic acid in its properties, and may even be formed from it. In the decomposition of ligneous fibre by heat, a peculiar volatile liquid is generated, closely allied to alcohol in its relations, and containing, like that, the oxyd of a compound radical, which was named methyle, to denote its nature and origin. Both of these compounds were however regarded as merely results of the decomposition of native products. The late researches of Cahours and Gerhardt on the fragrant oil of wintergreen, *Gaultheria procumbens*, have shown us that it is a compound of this methylic oxyd, with salicylic acid. Thus we are able by a simple recomposition, to form the oil of wintergreen in any quantity. This is only one example of the beautiful results which have been unexpectedly developed in this department of science. These discoveries we may observe, have been principally the results of accident; the object of the investigator having been to decompose substances by various agents, and study the results of this decomposition. A more difficult, but more fruitful field of investigation, seems to be the application of the knowledge that we have derived from these experiments, to the artificial formation of certain determinate products. Already we have a large class of artificial alkaloids, and although it is not yet certain that we have formed one of those bodies which exists in nature, we have produced compounds closely allied to the natural ones in their properties. In *anilene*, which we are now able to form by a number of reactions from different bodies, we have an alkaloid, which closely resembles both in its chemical relations and in its effects on the animal economy, the alkaline principles of *tobacco* and *Conium maculatum*. It is worthy of remark also, that the composition of these bodies differs only in the proportions of carbon and hydrogen. We form anilene by a peculiar action, from benzole, a carbo-hydrogen, derived from benzoic acid; and if among the great number of compounds of these two elements which result from the decomposition of various organic substances, we can find the hydro-carbon which bears the same relations to nicotine that benzole does to aniline, we can at once form from that compound, the alkaloid. In the present state of chemical science, this seems by no means improbable, and we may yet be able to form morphine and quinine to such an extent as will render us quite independent of the present sources of these important remedies.

5. *On the relations of Oil of Mustard;* (Chem. Gazette, No. 61, p. 178, and No. 75, p. 495.)—The late researches of MM. Wertheim, Gerhardt and Will, have shown that the oil of mustard is the sulpho-cyanid of a new radical, which is capable of forming combinations with sulphur,

chlorine and oxygen. This, because its compounds are also found in the garlic (*Allium sativa*), he has named *allyle.* The oil of mustard (*Sinapis nigra*) does not exist ready formed in the seeds, but is generated when they are bruised and treated with water. A reaction between two bodies previously existing in the seed, gives origin to the oil. The transformation is analogous to that which occurs in similar circumstances in bitter almonds, and produces hydruret of benzoyle.

The new radical allyle is C^6H^5, (or All,) and the *oil of mustard* All Cy S^2. The *essential oil of garlic*, to which it owes its characteristic odor, is found to be a sulphuret of allyle, All S, and the *oil of assafetida* another sulphuret of the same radical. An oxyd of allyle has also been obtained. When oil of mustard is heated for some time to a temperature of 248° in contact with caustic soda and lime, the pungent odor of mustard entirely disappears, and we obtain in its stead a liquid which has a faint aromatic odor like that of leeks. This substance analysis shows to be oxyd of allyle All O. The soda is in part converted into sulpho-cyanid of sodium. The reaction is very simple, $All\ Cy\ S^2 + Na\ O = All\ O + Na\ Cy\ S^2$. The oxyd of allyle appears to constitute the *volatile oil of leeks*, and also exists in the crude oil of garlic. It forms with nitrate of silver, a beautiful crystalline compound, which is $Ag\ O.\ All\ O + N\ O^5$.

The essential oil of garlic, as before mentioned, is a sulphuret of allyle, but in its crude state contains also the oxyd of allyle. It is easily formed from the oil of mustard. When we distill with a gentle heat a mixture of this with proto-sulphuret of potassium we obtain an oil which possesses none of the properties of the original, but evolves a powerful odor of garlic and is pure sulphuret of allyle. The reaction is similar to that affording the oxyd, $All\ Cy\ S^2 + K\ S = All\ S + K\ Cy\ S^2$. The oil of garlic forms interesting double salts with chlorid of mercury and bichlorid of platinum. With a solution of the bichlorid of platinum, an alcoholic solution of the oil forms an orange-yellow crystalline precipitate, which is $(Pt\ Cl^2, All\ Cl) + 3(Pt\ S^2, All\ S)$. Sulphuret of ammonium decomposes the chlorids, and we obtain an insoluble compound, which is the double sulphuret of platinum and allyle ($Pt\ S^2$, All S.) Similar compounds are formed with mercury. The precipitate with an alcoholic solution of chlorid of mercury is $2(Hg\ Cl,)\ All\ Cl, + 2(Hg\ S) All\ S$. When this is distilled with sulpho-cyanid of potassium, a decomposition ensues by which we obtain *the oil of mustard*. The reaction is between the double chlorids, forming chlorid of potassium and sulpho-cyanids of mercury and allyle; at the same time the double sulphuret is decomposed into sulphuret of mercury and sulphuret of allyle, which last is found in the receiver mixed with the oil of mustard.

If we add the oil of garlic to an alcoholic solution of nitrate of silver, we first obtain sulphuret of silver, followed by a crystalline precipitate. If we dissolve this last by boiling, and filter the hot solution, we obtain on cooling, beautiful white prismatic crystals of the compound of nitrate of the oxyd of allyle and silver, $AgO, AllO, N\,O^5$. Ammonia decomposes this, and liberates pure oxyd of allyle.

When we distill oil of mustard with one of the higher sulphurets of potassium, we obtain a crystalline compound which is probably a higher sulphuret of allyle. It has a powerful odor of assafetida, and is probably identical with the sulphuret observed in the oil of that substance. The roots of *Alliaria officinalis* yield a volatile oil, identical with that of mustard. These results are interesting as developing a new and beautiful relation between a number of organic substances. They show the simplicity which nature exhibits in all her operations, deriving a number of complex and apparently distinct bodies from a single radical, by combinations which we are able to imitate in our laboratories. These discoveries are a beautiful illustration of the doctrine of compound radicals. Although we have not as yet been able to isolate allyle, yet we can form all its combinations, and transfer it from one union to another, so as to afford the most satisfactory evidence of its existence.

6. *On the Acid of the Bark of Viburnum opulus;* (Chem. Gazette, No. 77, p. 9.)—L. von Monroe has shown that this acid, which was supposed to be identical with that obtained from the fat of the dolphin and named *phocenic acid*, is really valerianic acid. This confirms the results originally obtained by Dumas.

7. *On the Artificial formation of Specular Iron;* by T. S. Hunt.—The following is perhaps worth recording, as it beautifully confirms Mitscherlich's theory of the formation of this oxyd in volcanic products. I precipitated a concentrated solution of perchloride of iron by caustic ammonia, threw the thick magma upon a filter where it was allowed to drain until it became solid. This was then partially dried at a gentle heat, when it cracked into small angular fragments. These consisted of hydrated peroxyd of iron mechanically mixed with a large quantity of chlorid of ammonium. On heating this in a platinum crucible, to 400° or 500°, the vapors of water and the ammoniacal salt were abundantly disengaged, and the mass became inflated and porous. The residue however was not pure oxyd of iron, for on heating it to bright redness, fumes of chlorid of iron were evolved, accompanied by hydrochloric acid, and an abundant deposit of dark red-brown oxyd of iron coated the side of the crucible. On cooling, the oxyd was found coated with a brilliant iridescence, which was still more beautifully seen in the small cavities disclosed on breaking the porous mass. A microscopic

examination showed this coating to consist of small scales of specular oxyd of iron, which exhibited all the splendid tints of the beautiful iridescent specimens from Elba.

The reaction which produced the specular iron, is possibly the following: A portion of the ammoniacal salt confined in the mass, which was half an inch in diameter, was unable to escape before the exterior became ignited. The heated oxyd reacted upon the chlorid of ammonium to form chlorid of iron and water. Both of these bodies can probably exist undecomposed when in contact with oxyd of iron, or at least the oxyd and hydrochloric acid if formed, would immediately react upon each other. But when they come to the suface the oxyd is deposited and the hydrochloric acid escapes.

8. *On the Compounds of Boracic Acid with Ether;* by MM. EBELMAN and BOUQUET, (An. Chem. et de Phys., May, 1846.)—Chloride of boron is prepared by passing dry chlorine over an ignited mixture of boracic acid and charcoal, and the product is conducted into a bottle of alcohol, by which it is readily absorbed. The alcohol is kept cooled, and after a time separates into two layers; the upper one contains the new product, and the lower hydrochloric acid and water. The ethereal liquid is purified by distillation, till a product is obtained which boils at 246° F. It is a limpid fluid of a fragrant odor and burning taste. Its specific gravity at 60° is ·8849. It dissolves readily in alcohol and is also soluble in water, but is almost immediately decomposed by it into boracic acid and alcohol. It is combustible and burns with a fine green flame evolving fumes of boracic acid. Analysis gives for its composition the formula $BO_3, 3C_4H_5O$.

9. *Vitreous Boracic Ether.*—When the preceding compound is distilled from the original fluid, there remains in the retort a liquid, which on cooling forms a vitreous mass, having the odor of ordinary ether, but a very bitter taste. The composition appears to be $(BO_3)^2\ C_4H_5O$.

By a process similar to this, the authors have obtained compounds of boracic acid with the oxyds of methyle and amyle, which resemble in general character the borate of ethyle, and have a similar formula. One equivalent of boracic acid$=BO_3$ combines with 3 equivalents of the oxyds.

These compounds correspond to crystallized boracic acid $B_6O_3, 3HO$, while the vitreous ethyle compound is analogous to anhydrous borax $(BO_3)^2NaO$.

10. *Vitiated air in apartments*; (L'Institut, No. 654, July 15, 1846, p. 240.)—M. Lassaigne has shown by a series of investigations, that contrary to a common opinion, the air in a room which has served for respiration without being renewed, contains carbonic acid alike in every

part, above as well as below; the difference in proportion is but slight, and where appreciable, there is some reason to believe that the carbonic acid is in greater quantity in the upper parts of the room. These experiments establish the very important fact that all the air of a room must be changed in order to restore its purity. The plans sometimes resorted to, to draw off the air in the lower part of the room, or change this portion only by circulation, are wholly ineffectual as a means of ventilation.

11. *On the Products of the Oxydation of Gelatine by Chromic Acid;* by Prof. Marchand, (Chem. Gaz., No. 77, p. 10.)—40 grammes of gelatine were dissolved in a mixture of 1000 grammes of water and 300 of sulphuric acid, and the solution, after cooling, was mixed with 160 grammes of bichromate of potash. On heating the mixture the odors of the oil of bitter almonds and hydrocyanic acid are evolved. The distillate was agitated with oxyd of mercury, when a considerable quantity of cyanid of mercury and some formiate was obtained. The liquid distilled off from an excess of oxyd of mercury, still retained the odor of bitter almonds, which only disappeared after the addition of caustic potash and prolonged exposure to the air. From the solution a salt was obtained, soluble in alcohol, which gave with hydrochloric acid, crystals having all the characters of benzoic acid. These reactions leave no doubt that hydruret of benzoyle is a product of the oxydation of gelatine. When the gelatine is in excess we obtain nothing but carbonic with pure formic acid.

12. *Colors of Quartz;* by M. Heintz, (Poggend. Ann., l, 519.)—M. Heintz shows that the color of carnelian is not due to an organic substance; and that instead, it contains 0·05 per cent. of peroxyd of iron. He also states that the tint of amethyst is due to a compound of peroxyd of iron and soda, and not to manganese.

II. Mineralogy and Geology.

1. *Stroganowite*, a new mineral; by M. Hermann, (Journ. d'Erdmann, xxxiv, 177.)—This mineral was found in Russia, in the bed of the river Sludanka, in crystalline masses of a clear green color and foliated texture, cleaving also in two directions nearly at right angles. Specific gravity 2·79; hardness, that of apatite; lustre resinous; translucent or semi-transparent. It has the composition of scapolite, along with a portion of carbonate of lime, (a mixture ?) giving the formula $\dot{Ca}^2\dddot{Si}+2\dot{Al}\,\dddot{Si}+\dot{Ca}\,\ddot{C}$.

2. *Xylite*, a new mineral; by M. Hermann, (Journ. d'Erdmann, xxxiv, 177.)—Xylite is from the copper mines of the Ural. It is essentially a silicate of iron; it has a deep brown color, a fibrous fracture, specific

gravity 2·935; hardness inferior to calc spar. It is but slightly attacked by acids. It contains silica 44·06, peroxyd of iron 37·84, lime 6·58, magnesia 5·42, oxyd of copper 1.36, water 4·70=99·96.

3. *Antimoniate of Lead;* by M. Hermann, (Journ. d'Erdmann, xxxiv, 177.)—This ore is from the district of Nertschinsk in Russia. It is amorphous, with a compact texture and resinous lustre; color generally sulphur yellow, sometimes grayish, green or black; specific gravity, 4·60—4·76. It consists of antimonic acid 31·71, oxyd of lead 61·83, water 6·46=$\dot{P}b^3\dddot{\mathbf{S}}b+4\dot{\mathbf{H}}$.

4. *Native Titanium.*—It is reported by Mr. Rogers that native Titanium in cubes of a copper-red color has been found in the mines of Merthyr-Tydrill, in Cornwall, similar to those detected in the scoria of the furnaces at the same locality. It appears that in 1794, similar crystals were sent to Haüy, who considered them pyrites.

5. *Loxoclase;* by A. Breithaupt, (Phil. Mag., Aug., 1846, xxix, 150, from Poggend. Ann.)—Loxoclase is near feldspar in its characters, and comes from Hammond in the state of New York. It is distinguished by having an oblique cleavage parallel with the long diagonal though not always very distinct, and from this its name is derived. Hardness a little above ordinary feldspar; specific gravity 2·609—2·620; color yellowish gray, whitish and bluish gray. It has the general crystalline form of common feldspar, with the angle M : T=120° 15′. It fuses before the blowpipe with difficulty and shows in the outer flame an intense soda reaction. Composition, according to M. Plattner, silica 63·50, alumina 20·29, oxyd of iron 0·67, potash 3·03, soda 8·76, lime 3·22, water and fluorid of silicon 1·23. It occurs with pyroxene, graphite, and calc spar.

6. *Digenite and Cuproplumbite;* by M. Breithaupt, (Poggend. Ann., lxi, 671.)—These are two ores of copper from Chili. Digenite is a massive sulphuret of copper having a metallic lustre, a dark lead gray color, and giving a black streak. Hardness between 2·5 and 3·25 of Breithaupt's scale. Specific gravity 4·680. The same mineral has been found near Sangerhausen in Thuringia having the specific gravity 4·568. Composition; copper 70·20, silver 0·24, sulphur (loss) 29·56; formula, $\overset{|}{\mathbf{C}}u+4\overset{|}{C}u$ nearly. Cuproplumbite has the cleavage of galena, a metallic lustre, black streak; specific gravity 6·42; fuses easily. Composition, sulphuret of copper 24·45; sulphuret of lead 74·98, sulphuret of silver 0.57=$\overset{|}{\mathbf{C}}u+2\overset{|}{P}b$.

7. *Vanadate of Copper;* (L'Institut, No. 525, p. 68.)—This ore has been met with in the Ural, associated with sulphuret of copper, native copper, and malachite. It is in part pulverulent and also in reniform masses, consisting of folia of a citron yellow color and pearly lustre.

8. *Native Tin;* by M. HERMANN, (Jour. f. Prakt. Chem., xxxiii, 300.)—According to Hermann, native tin occurs in the gold washings of the Ural, in small gray metallic grains containing also some lead.

9. *Turgite;* by M. HERMANN, (Jour. f. Prakt. Chem., xxxiii, 96.)—Turgite is a hydrated peroxyd of iron from the Ural, of a brownish-red color, 3·54 to 3·74 specific gravity, consisting of peroxyd of iron 85·34, water 5·31, oxyd of lead and copper 1·85, gangue 7·50, formula $2\dddot{\mathbf{F}}\mathrm{e}+\dot{\mathbf{H}}$.

10. *Bodenite;* (Poggend., lxii, 636; Berz. Jahresb., xxv, 1845, 365.)—Breithaupt has given the name *Bodenite*, derived from the locality, Boden in Saxony, to a mineral resembling orthite, containing cerium.

11. *Parisite*, a new cerium mineral; by M. BUNSEN, (Ann. der Chem. und Pharm., 1845, No. 2.)—Parisite was discovered by M. Paris in the valley of Musso, New Grenada. It occurs crystallized in bipyramidal dodecahedrons; the basal angles are 164° 58′, and the lateral of the pyramid 120° 34′. It cleaves easily, parallel to the base; hardness between fluor and apatite; specific gravity =4·350; color reddish brown; fracture vitreous and conchoidal; transparent in thin fragments. Heated it loses water and carbonic acid and becomes friable. It is infusible and phosphorescent before the blow-pipe. Composition, carbonic acid 23·51, protoxyd of cerium, lantanum and didymium 59·44, lime 3·17, fluorid of calcium 11·50, water 2·38=100·00.

12. *Saccharite;* by M. SCHMIDT, (L'Institut, No. 549, p. 227.)—Saccharite resembles somewhat a granular feldspar, and is from Silesia. It is either white, or greenish from a mixture with pimelite. Specific gravity 2·668. It is infusible before the blowpipe alone, and with great difficulty with soda. M. Schmidt obtained in his analysis, silica 58·93, alumina 23·50, peroxyd of iron 1·27, oxyd of nickel 0·39, lime 5·67, magnesia 0·56, potash, 0·05, soda 7·42, water 2·21. Excluding the water, it gives the formula $\mathrm{R}^3\,\dddot{\mathrm{Si}}^2+3\dddot{\mathbf{R}}\dddot{\mathrm{Si}}^2$, which is identical with that of leucite.

13. *Fischerite;* (Berz. Jahresb., xxv, 1845, 390.)—Fischerite is a phosphate of alumina ($\ddddot{\mathbf{A}}\mathrm{l}^6\,\dddot{\mathbf{P}}^3$) containing, according to M. Hermann, 24 equiv. of water ($24\dot{\mathbf{H}}$). It comes from Nischne Tagilsk, in the Ural, where it occurs of a dull green color and translucent; specific gravity, 2·46. It is sometimes met with in transparent six-sided prisms.

14. *Turquois.*—M. Hermann finds that the blue Turquois has the formula $\dddot{\mathbf{A}}\mathrm{l}^2\,\dddot{\mathbf{P}}^3+4\,\dddot{\mathbf{A}}\mathrm{l}+15\dot{\mathbf{H}}$.

15. *Keilhauite*, a new mineral; by A. ERDMANN, (Kongl. Vet. Akad. Handl., 1845.)—Keilhauite was found near Arendal, in Norway, in a feldspathic rock. It is massive, of a brownish-black color, and grayish-

brown powder; splinters are brownish red by transmitted light. It has one distinct and two indistinct cleavages, with the surface of the first vitreous in lustre and the others resinous. Hardness between quartz and feldspar. Sp. grav.=3·69. Before the blowpipe it fuses easily with some effervescence to a black shining slag. With borax it dissolves, taking an iron color, but after strong reduction becomes blood red. In a fine powder, it dissolves entirely in muriatic acid. Erdmann obtained in an analysis, silica 30·00, lime 18·92, peroxyd of iron 6·35, alumina 6·09, sesquoxyd of manganese 0·67, oxyd of cerium 0·32, titanic acid 29·01, yttria 9·62; from which he deduced the approximate formula $3\dot{C}a^3\dddot{S}i+\dddot{\mathbf{R}}\dddot{S}i+\dot{Y}\ddot{T}i^3$. Scheerer (Poggend. Ann. lxiii, 459,) has named this mineral Yttro-titanite.

16. *Anatase, Brookite, and Rutile*, (Rammelsberg's Zweites Supplement; Jameson's Jour., xl, 383.)—Prof. Rose has shown (Poggend. Ann., lxi, 516,) that Anatase is pure titanic acid, like Brookite and Rutile. When exposed to heat, by which its specific gravity is not altered, or, to the action of solvents, it presents no phenomena different from those exhibited by the two minerals just mentioned, and the quantity of iron contained in it is still less than the amount in those two substances, (the Anatase of Brazil contains 0·25 per cent. oxide of iron.) Rutile, Brookite and Anatase, are the first decided example of a trimorphism, in whose members the titanic acid is distinguished by a different specific gravity. On being exposed to heat, however, the Anatase acquires the specific gravity of Brookite, and afterwards that of Rutile, and Brookite itself acquires the specific gravity of Rutile. It thus appears that, by the action of heat, the one substance is converted into the other; and precisely the same phenomena occur in the case of artificially prepared titanic acid.

17. *Kaliphite;* by M. Ivanoff, (Annuaire du Jour. des Mines de Russie, for 1841, St. Petersburg, 1844, p. 386; Berz. Jahresb., xxv, 1845, p. 331.)—Kaliphite is a Hungarian mineral, but the particular locality is not known. It forms a fragile, feathery mass, separating easily into acicular fibres; lustre resinous; opaque; powder reddish-brown; specific gravity, 2·81. Fuses easily on charcoal, before the blowpipe to a brown bead, gives an iron color with fluxes and becomes green with soda on platinum, affords much water and dissolves easily in muriatic acid. Composition, peroxyd of iron 28·80, binoxyd of manganese 28·13, water 19·01, silica 12·10, oxyd of zinc 6·30, lime 2·55, titanic acid 1·20, alumina 0·60, magnesia 0.70=99·39; formula, $2(\dot{Z}n, \dot{C}a)\dddot{S}i+3\dddot{\mathbf{F}}e\,\dot{\mathbf{H}}^2+8+\ddot{M}n\,\dot{\mathbf{H}}^2$.

18. *Amoibite;* (Jour. f. Pr. Chem. xxxiii, 402.)—This name is proposed by v. Kobell, for an ore of nickel, from Litchtenberg, in the Fichtelgebirge, which has the composition, nickel 37·34, iron 2·50, lead

0·82, cobalt, *a trace*, arsenic 45·34, sulphur 14·00=100; leading to the formula $Ni^2(As, S)^3$. It crystallizes in the tesseral system, and has the specific gravity 6·08. Heated in an open tube it affords arsenous acid, metallic arsenic, and sulphuret of arsenic. It fuses easily before the blowpipe, disengaging arsenical fumes. Nitric acid dissolves it, with a deposition of the sulphur.

19. *Margarodite.*—This name has been given by Schafhäutl, to the *schistose talc of Zillerthal*, a mineral allied to mica, and consisting of silica 47·05, alumina 34·90, peroxyd of iron 1·50, magnesia 1·95, potash 7·96, soda 4·07, water 1·45=98·88.

20. *Mowenite and Harmotome;* (L'Institut, No. 644.)—MM. Damour and Descloizeaux, suggest the propriety of uniting the mowenite of Thomson, with harmotome, both on crystallographic grounds and chemical composition. Mowenite afforded on analysis, silica 47·60, alumina 16·39, baryta 20·86, oxyd of iron 0·65, potash 0·81, soda 0·74, water 14·16=101·21.

21. *Brochantite and Krisuvigite;* (Poggend., Ann. lxii, 138; Berz. Jahresb., xxv, 1845, 395.)—M. Rammelsberg obtains for the formula of Brochantite $Cu\dddot{S}+3Cu\mathbf{H}$, which is also that of the so-called Krisuvigite.

22. *Perowskite;* (Poggend. Ann., lxii, 596; Berz. Jahresb., xxv, 1845, 370.)—Perowskite has been analyzed in the laboratory of H. Rose, and found to be a titanate of lime, with the formula $\dot{Ca}\ddot{Ti}$.

23. *Phacolite;* (Poggend., lxii, 149; Berz. Jahresb., xxv, 1845, 363.)—The Phacolite of Leipa in Bohemia, has been analyzed by Rammelsberg, who obtained the formula $2\dot{R}\dddot{Si}+\mathbf{\dddot{Al}}^2\dddot{Si}^3+10\mathbf{H}$; he remarks that the result agrees precisely with Connell's analysis of Levyne.

24. *Mica;* (Pogg. Ann., lxi, 377; Berz. Jahresb., xxv, 1845, 359.)—M. Lohmeyer, by an analysis in H. Rose's laboratory, obtained for the formula of a hexagonal lithia-mica, from Zinnwald, $KF+\mathbf{\dddot{R}}^2\dddot{Si}^3$, a little soda and lithia being substituted for part of the potash.

A dark greenish-black mica from Vesuvius afforded M. Chodnew, silica 40·91, alumina 17·79, peroxyd of iron 11·02, magnesia 19·04, lime 0·30, potash 9·96, with no fluorine or chlorine; giving the formula $\dot{Mg}^3\dddot{Si}+\mathbf{\dddot{Al}}\dddot{Si}$, some potash being included with the magnesia, and oxyd of iron with the alumina.

25. *Arragonite and Calc Spar;* (L'Institut, No. 654, July 15, 1846, p. 240.)—MM. Silberman and P. A. Favre have arrived at the conclusion that these two minerals are isomeric, and that the dimorphism of carbonate of lime is due to this principle. The arragonite is shown to be the higher of the isomeric compounds.

26. *Bucholzite of Chester, Pennsylvania;* (Berz. Jahresb., xxiv, 1844.)—Erdmann has determined the composition of this mineral as follows:—silica 40·08, alumina 58·88, protoxyd of manganese 0·74= 99·67, which approaches that of andalusite, and gives the same formula, $\dddot{\mathbf{A}}l^4\dddot{S}i^3$.

27. *Sillimanite;* (Ofversigt af K. V. Ac. Förhandl., 1844, 91; Berz. Jahresb., xxv, for 1845, 348.)—M. Staaf, in Svanberg's laboratory has analyzed the Sillimanite of Pettypaug (Chester) near Saybrook in Connecticut, and found for its composition, silica 33·362, alumina 58·622, peroxyd of iron 2·174, magnesia 0·398, lime *a trace*, evaporated 0·428=98·984: which affords the formula of Kyanite, A^3S^2.

28. *Bismuth Silver;* (Ann. des Mines, 4 Ser., vi, 165.)—Domeyko gives for the composition of a bismuth silver from Copiapo, S. A., silver 60·1, bismuth 10.1, copper 7·8, arsenic 2·8, gangue 19·2. The silver compound, omitting the copper, &c., equals $Bi\,Ag^6$.

29. *Arsenical Antimony;* (Poggend. Ann., lxi, 137; Berz. Jahresb., xxv, 1845, 334.)—This ore from Allemont in Frankreich, has been analyzed by Rammelsberg, with the result, antimony 37·85, arsenic 62·15=$Sb\,As^3$.

30. *Staurotide;* by M. Jacobson, (Poggend. Ann., lxii, 419.)—The staurotide of St. Gothard has afforded M. Jacobson, under the direction of H. Rose, silica 29·72, alumina 54·72, peroxyd of iron 15·69, magnesia 1·85=101·98. Other analyses by him correspond nearly with the one here cited. The above gives the formula $\dddot{\mathbf{A}}l^2\dddot{S}i$ or A^2S, the oxyd of iron, being included with the alumina.

31. *Scolezite and Natrolite;* (Poggend. Ann., lix, 368 and 373.)—An analysis of scolezite by Gülich gives for its composition, silica 46·76, alumina 26·22, lime 13·68, water 13·94, corresponding to the simple formula, $\dot{C}a\dddot{S}i+\dddot{\mathbf{A}}l\,\dddot{S}i+3\bar{\mathbf{H}}$.

Natrolite, according to analyses by Sander and Scheerer, affords the formula $\dot{N}a\dddot{S}i+\dddot{\mathbf{A}}l\,\dddot{S}i+2\bar{\mathbf{H}}$. One of Scheerer's analyses (of the var. Bergmannite) gave silica 48·12, alumina 26·96, lime 0·69, peroxyd of iron 0·22, soda 14·23, potash, *a trace*, water 10·48.

32. *On Iolite;* by W. Haidinger, (Pogg. Annal., 1846, lxvii, 441.)—In an elaborate memoir on the mineral Iolite, including its several varieties, M. Haidinger shows that the so-called mineral species, Pinite, Fahlunite, Weissite, Bonsdorffite or Hydrous Iolite, Gigantolite, Chlorophyllite, Praseolite, Esmarkite, and perhaps also Oosite,* are only

* M. Haidinger cites the suggestion made by Mr. Dana in his Mineralogy, (2d edit. p. 307,) that several of the above-enumerated minerals were derived from the alteration of Iolite.

pseudomorphs of Iolite, arising from a change of composition in crystals of this species. The change approximates the material to the mica or steatite family, altering the crystallization and rendering the structure foliated or micaceous, parallel to the base of the prisms.

33. *Gold at Dedham, Mass.;* by J. H. BLAKE, (communicated for this Journal.)—Recently, upon exposing to view a small portion of a vein of quartz in granite in the town of Dedham, I discovered numerous small particles of gold, some of them weighing from two tenths to eight tenths of a grain. The average width of this vein is about four inches; its course is E. 10° N. by W. 10° S., and its dip is to the southward at an angle of 76°.

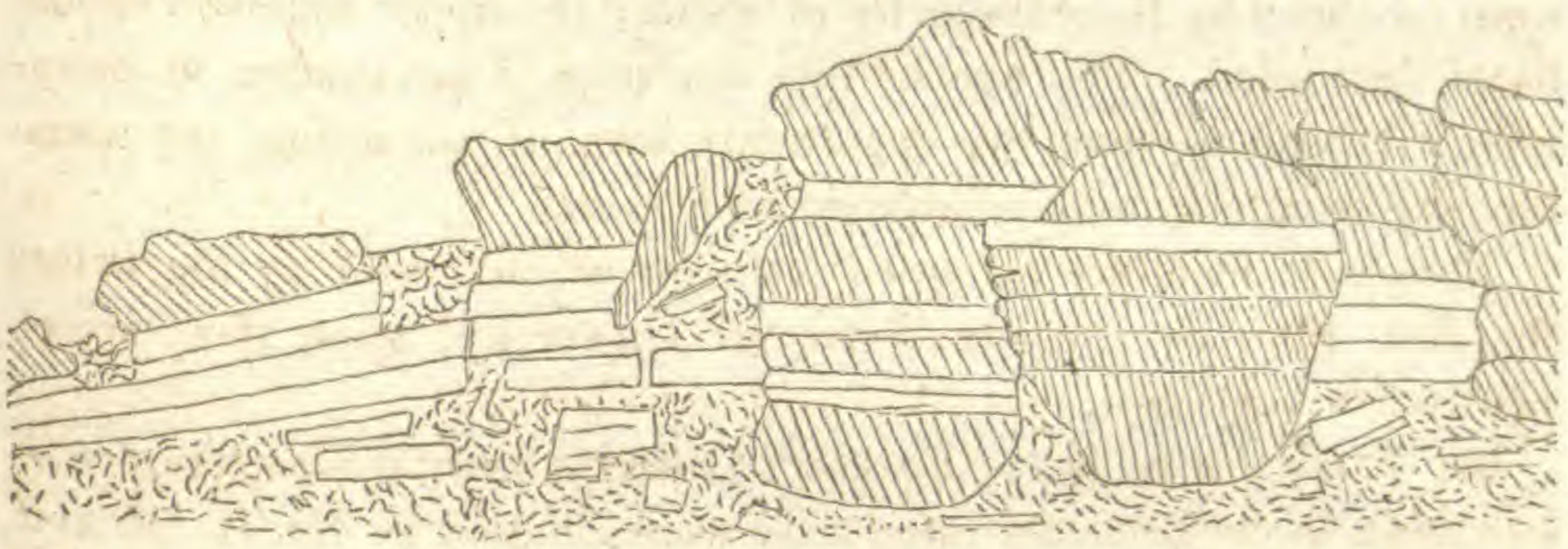
Occurring in the same vein there is found also sulphuret, black oxide and carbonate of copper, together with galena containing silver. Another vein affording galena, about five feet south of this vein, and having a like direction and inclination, has been exposed.

34. *Gold washings of the Rhine;* by M. DAUBRÉE, (L'Institut, No. 654, July 15, 1846.)—Some centuries past, the gold washings of the Rhine were quite flourishing: but since the discovery of America, they have lost their importance, till now there are but few persons employed upon the banks of this river, and only about 45,000 francs of gold are annually extracted between Bâsle and Manheim. Explorations have been made above Constance; but the most productive region is within the limits just stated; and here both banks are equally productive. The working is considered as paying when a workman can collect one and a half francs per day. The sands of the first quality have a richness represented by 0·000000562; those of the second quality, by 0·000000163; the sterile sands, taken promiscuously furnished scarcely 0·000000008. The sands of Siberia are five times more rich, and those of Chili ten times more so, than the best of the Rhine. The auriferous land of the river is calculated to contain 52,000 kilogrammes of gold, having a value of 165,828,000 francs; but it is mostly covered by soil under culture.

35. *Observations upon some Sandstone Rocks in Baldwin Co., Ala.;* by ARTEMAS BIGELOW.—I perceive by Mr. Lyell's letter in the March number of this Journal, that he has recently been in Alabama; but he makes no mention of a sandstone formation, which is quite extensive in the southern part of that state. Mr. Buckley, in one of the former numbers of the Journal, mentions it as being near the rocks in which the Zeuglodon is found, and as containing tubes of sandstone. It is also exposed near Pensacola. In Baldwin Co. it is exposed frequently through an extent of several miles along the sloping ground which descends to the Tensaw River; which river divides from the Mobile on the east and unites again at the Bay. I have found the sandstone, also on the level land more than six miles from the river.

Baldwin Co. is a part of that alluvial region lying along the Atlantic Ocean and the Gulf of Mexico. It extends from the Gulf along the east side of Mobile Bay, Tensaw and Mobile rivers, about 100 miles, and is about 50 wide in its broadest part. Its general surface is nearly level, covered with a continuous forest of the long-leaved-pine, with the exception of here and there savannahs, which are wet and miry, producing tall rank grass. On the edge of one of these, a large quantity of clear water boils up with much force, through a bed of quicksand. There are also numerous small ponds. Wherever the recent action of water has worn away the earth for several feet, beds of clay are exposed. This surface is about 200 feet above the Tensaw River; at about two miles distant from the river, it begins to slope down to it, and is cut into deep ravines, from the sides of which and upon the sloping surface, the sandstone is exposed. First, nearly on the height of land, are found tubes like those mentioned by Mr. Buckley, with this difference, those contained yellow ochre, these contain fine or coarse sand varying in color from the purest white through the shades of yellow to almost a red; the sand is stratified, generally lengthwise the tubes, sometimes transversely. In some localities these tubes contain silicified wood; the wood is found, in small fragments, in great abundance. I have dug out tubes from four to six feet long. About 60 feet below these, three quarters of a mile distant, are three or four small masses of the sandstone jutting from the sloping surface, which contain abundant but very obscure impressions of shells, apparently all bivalves. There are evidently several genera; the outlines of some are quite regular, and in two or three a part of the hinge is discernible. Still lower 40 or 50 feet, a quarter of a mile distant, the sandstone is exposed several feet thick, but I could not find any organic remains. The impressions of shells contained yellow ochre.

At the highest point, where the tubes are found, there are several ledges of the sandstone, over which fragments are scattered, bearing N. E. and S. W., appearing to have been washed by currents of water from the north. The strata vary in thickness from one half an inch to two inches; are inclined at an angle of 15°, 25°, and 30°, according to the locality, generally about 30°; and dip to a point a little S. of E. as if deposited from the W. or N. W. They are very much fractured, the faults perpendicular, yet the sandstone appears to be in its original position. The evidence for this is the fact, that the tubes are nearly all found horizontal, which would be their proper position if formed around sunken wood, as I suppose they were. The strata are every where at an angle of about 30° to the tubes; these are imbedded in the sandstone; they are nearly as hard again as the strata, the proportion of iron being so great that they are of a very dark iron color. I excavated to the depth of about six feet under one of the ledges, and found that the stone had entirely decomposed, leaving the tubes smooth and perfect, filled with variously colored sand. The fact that the sandstone, is so much decomposed under the surface, has led me to think that much of this sandy region in Alabama has been formed by the wearing away of this formation. The evidences tend to show that it extended over a large portion of South Alabama, but organic remains are discovered only in a few places. It is questionable whether impressions of shells can be found in any other place than the one I have mentioned, and there the extent of surface exposed is not a rod square.



The above is a section of the upper part of a ledge showing the relative position of the tubes and the strata, and an appearance of having been undermined at one end. Wherever I have seen the sandstone so as to mark the strata, they are about as above, except at the lowest place, mentioned as 40 feet below the strata containing shells, and 100 below the above ledge, where the angle of inclination is 15°. There is a ledge five miles distant from the above, where fragments of tubes are found, much more elevated, as high probably as any portion of the country. Another locality where I found silicified wood, in fragments, scattered abundantly over the ground, is nearly as high as the last mentioned ledge.

The tubes are generally round or oval, from one half inch to 12 inches in diameter of various lengths,—I saw one six or seven feet long, and six inches in diameter;—they are not always perfectly straight, but generally curved or a little crooked; the layers are concentric, and vary in thickness; the stone forming the tube is sometimes an inch thick. Where they are exposed to the air, they are hollow; beneath the surface they are filled with sand as before described.

One specimen of the tubes containing silicified wood is six inches long and oval as if it had been compressed, an inch and a half in the greater diameter; the rings are very distinct in the wood, and it was entirely surrounded with stone. Some specimens of the wood had undergone partial decomposition.

These tubes appear to have been formed around wood, that was brought down by a river, or rivers, perhaps through numerous mouths, and deposited: after the tubes were formed, the wood at greater depths seems to have decomposed and passed off, and its place filled with various colored sand; that more elevated in its position, petrified, leaving us evidences by which to know the origin of the tubes. The sandstone was forming during this process, being thrown down at an angle of about 30°, as before stated, and in the same direction with the tubes, as if both were deposited by the same current. The lowest strata contained no organic remains that I could discover; the middle were inhabited by several species of shells; the upper received deposits of drift-wood. The age of this sandstone I am unable to determine; I hope to have the opportunity soon of submitting my specimens to some one well acquainted with fossils.

The above facts are extracted from an article, read by me before the Nat. Hist. Soc. at the Wesleyan University, upon this subject, nearly five years ago.

36. *Fossil Forest in the Parkfield Colliery, near Wolverhampton.*—In a seam of coal, seventy three trees were counted by Mr. H. Bêckett, scattered over a quarter of an acre. The trunks occupy the whole thickness of the coal seam, about a foot and a half, but do not pass through the shale above. Above this upper shale, there were remains of another forest, of similar character. One of the stumps examined was perfectly bituminized, and preserved its shape unflattened; it was four feet in circumference, and the roots spread to a distance of nearly two feet. The trunk and roots were covered with a bark about half an inch thick, which was rather brittle; the interior, two feet in diameter, was more earthy and concentrically lamellar. The trees were all upright, and are said by Mr. Beckett, to present undoubted evidence of having grown on the spot.

Mr. Wm. Ick, describing the same region, states that some of the trees are eight feet in circumference, and seventy are exposed to view on one area, broken off near the roots, while the prostrate trunks are lying across each other in every direction. One of these trunks was thirty feet in length. In a thickness of twelve feet, he distinguishes three beds of coal and remains of as many distinct forests. The trees are supposed to be Coniferæ.

37. *Phyllite.*—This mineral, which, as published by Alger, is probably identical with Ottrelite, was referred erroneously by Dr. Thomson, who first described it, to Sterling, Mass., whereas it was found by Prof. L. Vanuxem in the "town of Newport, R. I., where (in 1823) it occurred abundantly in 'mica shist,' in the stone walls of the enclosures, and also near the south ferry."

III. Zoology and Botany.

1. *Report on Scientific Nomenclature*, (Proceedings of the Sixth Annual Meeting of the Assoc. of Am. Geol. and Nat. 1845, p. 69.)—Your Committee on Nomenclature having revised the laws and suggestions on this subject, published in the British Association, concur in recommending their general adoption. They have hesitated only with regard to writing names derived from persons or localities with an initial small letter instead of a capital. In citing the names of original discoverers in connection with that of a subsequent systematist by whom the original name had been changed, they have preferred, as most simple and concise, the plan which is proposed in the Report referred to, in a note to page 120, where this subject is discussed.

The following abstract has been made out in as concise a manner as possible, to secure more easy reference, and a more extended circulation: but they would strongly urge the perusal of the whole Report in the volume of the British Association for 1842, (pp. 105 to 121,) in which numerous examples are given by way of illustration, and the reasons for adopting the various laws are presented in a forcible and lucid manner.*

I. Law of Priority, with its Limitations.

§ 1. The name originally given to a group or species by its founder, should be retained, to the exclusion of all subsequent synonyms.

The systematic nomenclature having originated with Linnæus, this law is not to extend to the writings of more ancient authors.

§ 2. In the progress of science it often becomes necessary to restrict or extend the characteristics of a genus, or subdivide a genus into several genera. The following principles bearing upon the above law, should be adopted in making such changes.

a. When several smaller genera are united in one, the name of the earliest, if otherwise unobjectionable, should be selected for the name of the whole group.

b. When a genus is subdivided, the original generic name should not be cancelled, but should be retained for that portion of it which was considered typical by the author: or if the evidence as to the original type is not clear and indisputable, it may be given to any portion of it.

c. When two authors define and name the same genus, *both making it exactly of the same extent*, the latter name should be cancelled *in toto*, and not retained in a modified sense: *except*, when its type (as laid down by its author) belongs to a different section of the genus from that of the other name, and both sections are elevated to genera.

For example—the genus *Monaulus* of Vieillot, (1816,) is a precise equivalent to the *Lophophorus* of Temminck, (1813,) both authors having adopted the same

* The Report is here given as it was finally adopted.

species as their type; and therefore, when the latter genus came, in the course of time, to be divided into two, it was incorrect to give the condemned name *Monaulus* to one of the portions. The names *Œdemia* and *Melanetta* were originally synonyms; but their respective types were taken from different sections of the group, and consequently, on raising these two sections to genera, these names are retained for the groups.

§ 3. There are other limitations of the law of priority, arising from violations of the rules of propriety in the introduction of names. They are as follows:—

a. Names given to species or groups unaccompanied by published characteristic descriptions, should yield place to the earliest name accompanying such descriptions.

It has been customary with some naturalists to give names to species in their cabinets, or in a published catalogue, and on this ground, to claim authority for such names. This should not be allowed. Neither is it sufficient that the description appear in a public newspaper, or in a journal not generally known for its scientific character, or in language so brief and indefinite that the object cannot be recognized by it.

b. A name of a species already in use for another species of the same genus, should be changed: also, a generic name in Zoology, before employed for a genus in that kingdom should be changed; and the same in the Vegetable kingdom.

c. A name glaringly opposed in its signification to the essential characteristics of a species or group, and likely to propagate important errors, may be changed.

Such terms as *Monodon*, *Caprimulgus*, *Paradisea apoda*, and *Monoculus*, have acquired sufficient currency no longer to cause error, and are therefore retained without inconvenience. Names derived from localities, where the species are found to have wider limits, should still be retained. But when we find a Batrachian reptile named in violation of its true affinities, *Mastodonsaurus*, or when a name is derived from an accidental monstrosity, as in *Picus semirostris* of Linnæus and *Helix disjuncta* of Turton, another name should be substituted. This privilege should be allowed only in extreme cases.

d. When the name of a species is afterwards made the name of a genus to include that species, a new specific name should be given.

The generic name *Pyrrhocorax* was applied to the species called by Linnæus, *Corvus pyrrhocorax*. It therefore became necessary to change the specific name, and *alpinus* was substituted. The practice of thus elevating specific names to generic is a bad one. See § 6, i.

II. LAWS WITH REGARD TO ORTHOGRAPHY.

§. 4. In writing systematic names, the rules of Latin orthography should be adhered to; *except* in words derived from proper names, in which only the termination should be latinized.

Proper names of persons would often become quite unintelligible if modified so as to conform throughout to Latin orthography. We should not recognize *Knighti*, *Woodwardi*, in the words *Cnichti*, *Vudvardi*. But words of barbarous origin, having no fixed orthography, are more pliable, and hence when adopted into the Latin, should be rendered as classical in appearance as is consistent with the preservation of their original sound.

a. In converting Greek words into Latin the following principles should be regarded.

Greek.		Latin.	Greek.		Latin.
αι	becomes	æ	θ	becomes	th
ει	"	i	φ	"	ph
ος terminal	"	us	χ	"	ch
ον "	"	um	κ	"	c
ου	"	u	γκ	"	nch
οι	"	œ	γγ	"	ng
υ	"	y	The aspirate (ʽ)		h

b. In compounding two Greek words, the first of the two words should have the form of the genitive case, dropping only the terminal consonant; as from ορνις, *bird*, and ρυγχος, *beak*, we have *Ornithorynchus*—not Ornirhynchus.

c. Words of different languages must never be compounded together. We add—

d. In compounding two Latin words, the same rule should be followed, except that *i* should be substituted when the genitive ends in *æ*; *pennæformis* should be *penniformis.*

e. Specific names, derived from localities, should terminate in *ensis:* those derived from names of persons, when given in honor of the discoverer, should end in the genitive *i*, or *ii*, (*i*, when the name ends in a consonant, and *ii* when in a vowel); but when in compliment to a person not a discoverer, the adjective should end in *anus*. But names derived from the names of persons or localities are very objectionable: see beyond, § 6, *b*, *c*.

III. RECOMMENDATIONS FOR THE FUTURE IMPROVEMENT OF SYSTEMATIC NOMENCLATURE.

The following suggestions, although they cannot be invested with the authority of laws, are worthy of being strictly regarded in the future introduction of scientific names.

§ 5. The best names are those derived from the Greek or Latin language, the former being in general preferable for generic names, and the latter for specific.

§ 6. It is desirable,

a. To select names which may indicate some sensible characteristic of the object: this will greatly aid the memory.

b. To avoid specific names derived from localities.

c. To avoid invariably deriving generic and specific names from the names of persons.

d. To avoid comparative names, such as *Picoides*, *Emberizoides*, *maximus*, *minor*, *minimus*, &c.

e. To avoid ancient names of species, except when they can be correctly applied with their ancient signification.

f. To avoid names closely resembling others in use.

g. To avoid names having no meaning.

h. To avoid the introduction, under a new signification, of names that have been once ranked among synonyms, except in the cases alluded to in § 2, *c*.

i. To avoid making a generic name out of a former specific name.

k. To avoid introducing for a genus in Zoology a name already in use for a genus in Botany, and the reverse.

l. To avoid names of harsh and inelegant pronunciation.

§ 7. It is recommended that names of Families should end uniformly in *idæ*, and Subfamilies in *inæ*.

These names are formed by changing the last syllable of the genitive into *idæ* or *inæ*; as *Strix* gives *Strigidæ*, from the genitive *Strigis*, *Buceros* gives *Bucerotidæ*, from the genitive *Bucerotis*; not *Strixidæ*, *Buceridæ*.

§ 8. It is recommended that generic names, and specific names which are derived from names of persons, be written with an initial capital; that all other specific names be written with a small initial letter.

This principle is introduced with reference to names of this kind already in use; for it is to be hoped that they may not be added to in future. (§ 6, *c*.)

§ 9. It is recommended that the original authority of a species always follow the name *in brackets*; and if the name be subsequently altered, the authority for the same as altered, be added without brackets.

It has been common for systematists to change a generic name, and then to add their own name to all the species. To prevent this injustice, which is no less than a kind of piracy, the above rule is proposed. As an example—the *Tyrannus crinitus* of Swainson is the *Muscicapa crinita* of Linnæus: to distinguish here the author of the former name and give due justice to Linnæus, it may be written, *Tyrannus crinitus*, (Linn.) Swain. By this we do not intimate whether the genus *Tyrannus* is Swainson's or not; it is sufficient for the purposes of science to show here that the above title, as a whole, was first adopted by Swainson. The authority for the genus will be found elsewhere.

§ 10. It is recommended that when an author, through ignorance of what his predecessors have done, gives to a species an appropriated specific name, the name of such author be omitted.

§ 11. It is recommended that when an author only corrects a false orthography, his name be not added as authority for the corrected term.

§ 12. It is recommended that in subdividing a genus, the new generic names proposed for the subdivisions formed, agree in gender with that of the original genus.

§ 13. It is recommended that in proposing new genera, the etymology of the names be always stated; and that one species be pointed out as a type or standard of reference.

§ 14. It is recommended that new genera and species be amply defined, and that the descriptions be inserted in such periodical or other works as are likely to obtain immediate and extensive circulation.

JAMES D. DANA.	A. BINNEY.
S. S. HALDEMAN.	C. U. SHEPARD.
D. H. STORER.	C. DEWEY.
A. A. GOULD.	J. D. WHELPLEY.
E. C. HERRICK.	

2. *Aphides.*—Mr. Francis Walker of London is engaged in the preparation of a work on the Aphides of Great Britain.

3. *Caricography.*—In the third portion of Dr. Boott's memoir on new or little known Carices, read before the Linnæan Society of London in February last, seventeen species are described, the characters of which are given in the Proceedings of the Linn. Society, published in *Ann. and Mag. Nat. Hist.* for September. The following are natives of North America, viz. *Carex Geyeri*, gathered in the Rocky Mountains by C. A. Geyer;—allied to *C. phyllostachys*: *C. juncea*, Wild. (to which Dr. Boott refers *C. miser*, Buckley, described in this Journal): *C. Sullivantii*, first described in this Journal, vol. xlii, p. 29; and *C. Tuckermani*, (*C. bullata*, Tuckerm., not of *Schk.*)

4. *Fossil Ferns from Frostburg, Maryland, collected by Mr. Lyell;* by C. T. F. BUNBURY, Esq., (Quart. Jour. Geol. Soc., ii, 82; read before the Geol. Soc. of London, Dec., 1845.)—Mr. Bunbury in a short memoir describes three species of ferns from Frostburg, two of which are figured. The first is supposed to be identical with the *Diplazites emarginatus* of Göppert. Mr. Bunbury shows that the genus Diplazites is founded on an error, and proposes to retain the species for the present in the genus Pecopteris, as P. emarginata, of which he gives the following description:

P. fronde pinnatâ (?): pinnis ligulatis obtusis latè et obtusissimè crenatis; basi subcontractis; costâ validâ apice attenuatâ; venis costæ subperpendicularibus pinnatis; venulis valdè obliquis, infimis in angulum acutum confluentibus; soris rotundis confertis inter venas biserialibus.

The second species is described as new, and named *Pecopteris elliptica.*

Description.—P. fronde bipinnatâ: pinnulis ellipticis oblongisque convexis integerrimis apice rotundatis basi contractis discretis remotiusculis; venis obliquis prope basin furcatis; soris subrotundis confertissimis. It is stated to be near the P.

adiantoides (Fossil Flora, i, 37) in the form of its pinnules; but the description of the latter is insufficient to determine their identity.

The third species agrees nearly with the *Danaites asplenioides* of Göppert, and is ranked for the present as a variety of it (var. *major*). This species is described as follows:

The frond appears to be bipinnate, and if a flattened stem (apparently the stipes of a fern) which occurs in the same slab belonged to this plant, it was of large size, for the stem in question, in its compressed state, measures an inch and a half across. The pinnules are closely set, oblique, rounded at the end, slightly combined at the base, but neither dilated nor decurrent, of an oblong or broadly linear form, flat, or scarcely convex, about four-tenths of an inch long, and about half as much in breadth. Veins very indistinctly marked, but seemingly nearly perpendicular to the margin. The fructiferous pinnules (which are on a separate pinna, but which I believe to belong to the same species) are rather larger than the others, but of the same shape; the fructification has the appearance of linear masses, placed parallel and nearly contiguous to one another, perpendicular to the midrib, and extending from it quite to the margin. Its general resemblance to the fructification of the curious genus *Danæa* is very striking, but I am not quite satisfied that it is really of the same nature; for on a close examination one may detect traces of round spots; and perhaps the apparently linear masses may have been made up by the aggregation of numerous round ones.

Mr. Bunbury remarks that "although the appearances of fructification in all these three plants are clear and unequivocal, yet in the first two species at least, it is invariably the upper surface of the frond that is exhibited to our view; now, in all recent ferns, the fructification is situated on the under surface: we must therefore suppose that what we see in these specimens are not the masses of capsules themselves, but the impressions of them, as it were, stamped through the substance of the leaves by the pressure to which they were subjected in the process of fossilization. This appears to be most usually the case with those fossil ferns which occur in a fertile state, and may be one reason why it is more difficult to determine with precision the characters of the fructification in these than in the recent plants. Dr. Lindley long ago observed,* that fossil ferns are much more often found with their upper than with their lower surface exposed to view, the lower seeming to adhere more closely to the matrix; and Professor Göppert,† in his curious experiments on the artificial production of vegetable impressions, found that plants of this tribe did, in fact, constantly remain attached to the substance in which they were imbedded, by their lower and not by their upper surface, especially if they were in fructification.

The other plants procured by Mr. Lyell are the Neuropteris cordata, N. gigantea?, Cyclopteris (?), Pecopteris arborescens, P. abbreviata?, P. ——?, Lepidodendron tetragonum, L. aculeatum, L. ——??, Sigillaria reniformis?, Stigmaria ficoides, Asterophyllites foliosa, A. tuberculata?, A. equisetiformis?, A. ——?, Artisia ——?, Calamites nodosus, C. dubius?.

* Fossil Flora, text to t. 83. † Syst. Filicum Fossilium, p. 293.

IV. Meteorology.

1. *Abstract of a Meteorological Register kept in the city of Natchez, Lat.* 31° 34′, *Lon.* 91° 21′ 42″, *for ten years; to show the monthly and annual mean, maximum and minimum of the thermometer and barometer, the weather, prevailing winds, and depth of rain;* by Henry Tooley, Sen.

Months.	Thermometer.			Barometer.			Weather and Days.			Prevailing winds.							
	Mean.	Max.	Min.	Mean.	Max.	Min.	Clear.	Cloudy.	Rainy.	S.	S.W.	S.E.	E.	N.	N.E.	N.W.	W.
1836.																	
January,	51·4	69·5	34·5	29·783	30·105	29·485	8	8	15	12	3	0	4	14	1	2	2
February,	53·3	63·	35·5	·797	·155	·545	6	12	11	12	1	3	6	12	4	1	1
March,	56·4	72·	41·5	·798	·075	·440	7	13	11	12	2	2	5	13	2	2	0
April,	70·6	75·5	60·	.705	29·930	·535	6	12	12	22	5	0	4	10	0	0	1
May,	73·6	77·5	68·	·646	·800	·350	2	17	12	19	8	0	6	7	2	1	0
June,	78·6	82·5	76·	·670	·773	·550	3	16	11	19	7	1	0	7	0	3	2
July,	81·5	85·2	74·2	·704	·745	·525	2	19	10	16	15	0	3	7	4	0	1
August,	81·3	85·5	75·5	·725	·810	·575	7	14	10	12	6	3	9	14	1	4	9
September,	77·4	81·	68·	·724	·840	·560	2	14	14	10	8	8	14	10	3	0	1
October,	61·4	74·	49·	·778	·820	·565	13	14	4	4	6	5	4	17	5	0	1
November,	52·6	67·	39·5	·809	30·040	·490	10	16	4	4	2	3	6	9	0	1	12
December,	46·2	64·	26·5	·807	·300	·610	10	13	8	10	3	8	9	11	0	0	4
	65·3	74·7	54·	29·743	29·946	29·519	76	168	122	154	66	33	72	131	20	14	34
1837.																	
January,	47·2	50·	35·3	29·753	29·966	29·500	11	7	13	8	6	3	5	16	7	2	11
February,	52·3	62·6	39·	·688	30·170	·600	8	10	10	10	3	5	14	15	4	8	11
March,	59·5	69·3	49·3	·773	·103	·540	7	12	12	12	5	8	15	22	2	5	1
April,	64·3	74·	50·	·686	·013	·246	10	14	6	15	13	1	10	19	4	3	7
May,	73·	81·6	61·	·697	29·833	·530	23	4	4	24	14	4	8	18	1	3	11
June,	80·7	87·	72·	·680	·826	·540	5	18	7	18	35	13	6	10	0	0	1
July,	83·3	86·3	79·	·764	·835	·693	0	21	10	14	14	6	5	10	3	4	6
August,	83·2	87·3	76·1	·777	·883	·583	0	25	6	4	6	2	10	17	6	3	6
September,	75·4	76·5	63·4	·764	·912	·662	4	16	10	1	8	8	17	7	5	1	3
October,	67·5	74·8	47·6	·883	30·116	·573	8	18	5	6	8	4	15	17	2	1	1
November,	63·5	71·3	47·3	·821	·070	·673	11	13	6	11	5	10	12	8	1	1	3
December,	53·7	57·6	38·	·614	·270	·470	7	15	9	6	6	2	7	14	2	3	4
	66·9	72·8	54·6	29·741	29·999	29·550	94	173	108	129	123	66	124	173	87	34	65
1838.																	
January,	51·6	68·	33·	30·040	30·376	29·666	5	18	8	8	4	7	4	12	2	2	0
February,	42·3	61·4	22.3	29·902	·253	·606	4	12	12	1	8	6	2	15	2	1	3
March,	60·8	73·3	43·3	·743	·030	·463	2	23	6	6	9	6	6	4	3	3	8
April,	69·3	73·	60·6	·708	29·999	·516	2	24	4	11	7	1	7	8	6	3	3
May,	68·4	75·3	60·	·679	·850	·546	1	17	13	5	5	9	2	5	5	2	6
June,	82·	86·6	70·6	·700	·813	·493	1	27	2	8	12	5	3	9	1	4	8
July,	81 3	85·	78·3	·793	·836	·706	0	19	12	17	8	10	8	7	0	2	14
August,	80·8	84·3	79·6	·742	·806	·690	0	19	12	10	11	7	5	2	3	3	6
September,	73·8	87·3	60·6	.706	·950	·520	10	14	6	0	2	2	11	21	9	5	2
October,	62·4	78·6	53·3	·825	30·010	·730	8	15	8	4	10	2	8	12	5	0	2
November,	52·7	68·3	41·	·884	·211	·540	5	18	7	6	4	2	7	14	3	3	1
December,	44·7	57·6	28·3	30·028	·246	·640	5	19	7	8	7	4	3	17	2	2	0
	64·1	74·3	53·4	29·788	30·002	29·593	53	225	97	84	87	61	67	132	41	30	53
1839.																	
January,	52·6	64·3	41·	29·728	30·160	29·513	0	21	10	12	5	5	2	11	2	6	6
February,	50·8	64·	38·	·693	·460	·543	5	13	10	2	6	4	4	9	7	4	6
March,	59·3	72·	32·6	·907	·403	·436	2	19	10	17	6	6	5	10	0	5	6
April,	75·1	77·7	61·6	·722	29·923	·563	2	24	4	12	8	12	4	2	2	3	3
May,	76·7	84·	64·6	·702	·933	·546	4	20	7	11	18	2	5	7	3	2	3
June,	82·6	85·6	73·6	·778	·830	·566	0	26	4	8	20	3	1	6	1	0	6
July,	83·8	87·	77·3	·701	·870	.660	0	23	8	10	14	5	9	8	1	0	4
August,	81·4	83·	76·3	·730	·793	·656	2	23	6	10	12	4	15	8	5	4	5
September,	77·	85·3	75·3	·797	·920	·563	4	23	3	6	12	5	4	9	12	2	1
October,	71·6	77·6	63·1	·819	·956	·620	8	20	3	7	7	11	13	14	2	1	0
November,	52·7	72·	29·3	·841	30·326	·783	3	17	10	8	5	3	7	14	4	0	4
December,	46·8	49·6	41·	·833	·160	·486	8	14	9	4	7	6	8	14	5	4	5
	67·8	75·1	56·1	29·771	29·999	29·579	38	243	84	107	120	66	77	112	44	28	49

Months.	Thermomet'r.			Barometer.			Weather and Days.			Prevailing Winds.								Rain.
	Mean.	Max.	Min.	Mean.	Max.	Min.	Clear.	Cloudy.	Rainy.	S.	S.W.	S.E.	E.	N.	N.E.	N.W.	W.	Inch.
1840.																		
Jan'ry,	49·4	65·	31·6	29·901	30·300	29·603	7	16	8	8	9	5	4	10	2	0	4	3·52
Feb'ry,	56·8	67·	32·	·911	·370	·573	2	15	12	14	4	3	7	5	2	1	1	3·04
March,	61·5	74·6	53·3	·728	29·936	·550	2	17	12	17	9	5	7	11	1	5	4	3·50
April,	71·2	80·6	57·3	·803	·978	·776	0	19	11	20	11	5	7	6	2	0	5	8.73
May,	72 5	78·3	62·	·659	·960	·450	2	25	4	11	9	2	13	6	5	3	5	2·25
June,	81·2	86·6	73·3	·756	·953	·690	3	18	9	14	7	1	11	3	0	1	7	4·19
July,	82·2	85·	76·	·799	·866	·753	0	17	14	16	14	8	9	14	3	2	0	7·70
Aug'st,	82·6	88·3	77·	·774	·903	·720	0	28	3	13	7	5	2	13	5	2	11	·75
Sept.	75·9	82·	66·3	·795	·903	·736	3	21	6	5	4	10	7	·19	15	2	4	3·90
Oct.	68·5	80·	51·3	·744	30·126	·653	4	21	6	13	6	8	7	16	4	4	7	4·68
Nov.	53·	71·3	33·3	·862	·116	·520	11	15	4	17	7	8	14	12	2	2	7	1·88
Dec.	50·2	64·	37.	·941	·146	·708	3	22	6	7	6	8	15	14	7	1	3	4·28
	67·1	76·8	46·7	29·806	30·046	29·644	37	234	95	155	93	68	103	130	48	23	58	48·48
1841.																		
Jan'ry,	47·1	65·6	25·3	29·771	30·176	29·400	1	14	16	8	6	10	9	11	6	4	7	13·80
Feb'ry,	54·6	67·3	30·3	·771	·206	·450	4	21	3	12	9	5	4	12	4	5	3	1·34
March,	61·2	70·6	39·	·738	·093	·400	4	17	10	11	7	19	8	5	0	5	7	4·73
April,	71·	77·3	62·6	·759	29·943	·486	0	21	9	12	14	9	5	8	1	2	14	2·16
May,	75.3	79·6	69·	·771	·960	·590	4	20	7	15	8	10	11	12	9	3	2	11·66
June,	81·5	85·3	74·	·713	·838	·640	0	20	10	12	16	7	6	12	5	5	5	2·12
July,	84·8	90·	81·	·831	·888	·740	0	24	7	14	20	3	5	12	1	3	6	1·44
Aug'st,	81·6	86·6	79·6	·808	·920	·703	4	18	9	7	6	10	14	20	2	2	5	3·05
Sept.	77·8	84·3	63·6	·730	·860	·620	2	19	9	10	8	12	3	11	4	2	2	4·32
Oct.	66·6	76·3	47·3	·840	30·186	·653	7	19	5	5	5	11	12	14	7	2	2	8·62
Nov.	59·7	75·	36·3	·827	·153	·516	9	17	4	8	4	7	9	13	2	2	2	2·53
Dec.	54·3	71·	35·	·883	·156	·580	7	14	10	9	7	7	4	11	4	1	4	4·01
	68·	76·5	53·5	29·786	30·031	29·682	42	214	99	123	110	110	89	137	45	36	59	59·78
1842.																		
Jan'ry,	54·9	71·3	44·3	29·888	30·093	29·660	5	16	10	9	12	7	4	8	4	0	5	3·52
Feb'ry,	54·2	71·3	41·3	·820	·133	·433	6	13	9	13	4	6	4	7	2	2	5	7·31
March,	69·1	76·	58·3	·889	30·270	·496	2	20	9	19	11	8	8	6	2	0	1	3·93
April,	70·9	74·3	56·3	·828	29·970	·496	6	16	8	16	10	7	3	9	1	5	5	5·07
May,	76·9	83·3	64·3	·832	30·056	·640	3	25	3	23	19	1	4	8	0	0	0	·45
June,	81·5	85·	79·6	·781	29·863	·670	1	20	9	22	16	5	7	6	2	0	5	6·40
July,	80·1	86·	71·	·857	·940	·696	0	24	7	10	14	7	9	13	0	0	4	1·74
Aug'st,	78·9	82·6	78·6	·818	·940	·696	2	19	10	16	7	2	9	9	3	1	5	1·94
Sept.	77·4	82·3	70·6	.754	·873	.690	0	18	12	9	2	17	10	7	8	0	1	4·64
Oct.	66·9	75·	53·6	·866	·993	·666	10	17	4	5	6	11	5	13	5	0	0	1·73
Nov.	54·	65·	32·6	·870	30·236	·510	2	19	9	4	4	12	8	13	1	2	3	5·42
Dec.	50·6	71·	34·3	·966	·316	·733	2	27	2	8	5	6	4	4	3	3	7	1·37
	67·4	76·8	56·9	29·847	30·056	29·623	39	234	92	154	110	89	75	103	31	13	41	43·52
1843.																		
Jan'ry,	54·	66·6	33·3	29·911	30·070	29·620	6	20	5	10	7	9	7	8	2	2	5	7·20
Feb'ry,	50·4	69·6	26·	·788	·043	·613	4	20	4	9	7	2	10	8	4	1	1	3·70
March,	46·8	64·	30·6	·791	·016	·576	5	18	8	8	5	8	9	17	5	4	5	6·06
April,	70·6	79·6	51·	·774	29·920	·646	3	23	4	16	11	3	7	4	3	1	2	5·16
May,	75·9	83·3	68·3	·789	·926	·629	7	18	6	17	11	9	2	8	7	2	0	2·16
June,	78·9	83·3	75·3	·784	·876	·583	0	16	14	8	14	13	12	6	1	0	5	10·68
July,	81·	86·3	78·5	·822	30·013	·733	1	20	10	5	16	19	1	10	1	0	4	6·75
Aug'st,	79·4	83·3	75·3	·830	29·903	·430	1	21	9	5	6	9	8	17	4	0	8	2·78
Sept.	79·6	83·6	73·3	·796	·976	·660	0	18	12	9	12	18	6	3	5	0	4	4·93
Oct.	63·9	74·9	42·6	·834	30·136	·616	4	20	7	9	9	8	9	6	3	1	2	4·04
Nov.	60·9	73·6	48·6	·852	·066	·700	0	18	12	10	4	11	4	11	4	0	0	11·24
Dec.	51·8	64·6	41·6	·913	·300	·706	7	9	15	4	5	6	8	15	3	1	4	14·03
	66·1	76·3	53·7	29·721	30·020	29·625	38	221	106	120	107	115	83	113	42	12	40	78·73

Months.	Thermometer. Mean.	Max.	Min.	Barometer. Mean.	Max.	Min.	Weather and Days. Clear.	Cloudy.	Rainy.	Prevailing Winds. S.	S.W.	S.E.	E.	N.	N.E.	N.W.	W.	Rain. Inch
1844.																		
Jan'ry,	53·2	69·3	40·6	29·831	30·086	29·500	4	12	15	6	15	9	8	11	1	5	1	8·37
Feb'ry,	59·	72·	44·	·941	·130	·630	3	25	1	11	12	8	4	8	4	0	1	·05
March,	59.9	75·6	50·	·875	·133	·533	7	15	9	13	8	7	3	7	2	2	10	4·18
April,	71·2	80·3	59·	·870	·140	·666	1	25	4	26	9	10	1	4	0	0	1	·72
May,	77·9	83·	79·	·853	·046	·538	0	19	12	22	21	3	2	2	1	1	2	4·36
June,	80·6	83·	76·3	·809	29·836	·740	0	23	7	22	8	9	5	2	0	0	3	2·54
July,	84·2	86·6	81·	·826	·930	·746	0	22	9	22	20	3	7	5	0	0	3	2·34
Aug'st,	80·6	86·6	77.3	·762	·943	·660	1	18	12	14	11	8	12	9	4	1	3	4·79
Sept.	76·6	85·	55:	·837	·980	·753	2	24	4	5	1	6	15	15	2	2	0	3·94
Oct.	66·6	75·3	48·3	·829	30·040	·620	1	26	4	7	7	8	11	13	2	1	1	5·34
Nov.	59·2	74·3	46·6	·853	·060	·630	3	21	6	14	6	7	9	10	0	0	0	4·38
Dec.	50·5	60·6	35·3	·908	·136	·583	13	13	5	11	11	3	4	13	0	2	3	4·90
	68·2	77·6	57.	29·851	30·030	29·632	35	243	88	173	129	81	81	99	16	14	28	45·91
1845.																		
Jan'ry,	54·9	67·6	46·3	29·893	30·316	29·703	4	21	6	14	8	6	6	8	8	1	6	3·10
Feb'ry,	56·8	69·6	43·	·920	·193	·613	6	16	6	16	3	8	4	7	0	1	2	4·65
March,	62·2	71·3	46·	·896	·263	·813	3	15	13	14	3	7	8	11	1	0	6	6·43
April,	69·4	79·3	59·	·854	·016	·706	4	18	8	22	7	9	7	3	1	0	0	4·10
May,	74·1	77·3	65·3	·827	·026	·703	3	21	7	11	9	9	13	4	4	0	0	8·19
June,	81·5	86·	76·	·888	29·990	·803	0	21	9	21	15	8	2	2	1	0	1	3·47
July,	82·7	90·	78·	·831	·953	·716	3	16	12	18	14	6	3	9	2	1	6	3·98
Aug'st,	81·6	88·3	78·	843	·966	·706	3	20	8	23	11	7	6	10	2	2	3	2·68
Sept.	76·8	80·6	65·3	·818	·880	·663	7	13	10	16	3	5	12	9	2	2	0	9·35
Oct.	64·7	72·6	54·6	·897	30·158	·666	8	19	4	6	1	10	15	10	1	4	6	1·24
Nov.	56·2	71.	35·	·860	·050	·666	4	19	7	18	2	4	7	14	1	1	5	·87
Dec.	44·5	67.4	25·	·968	·194	·736	5	16	10	7	2	6	3	17	4	2	0	4·44
	67·1	76·7	51·4	29·874	30·083	29·707	50	215	100	181	78	80	84	104	27	14	35	53·10

RECAPITULATION.

1836,	65·3	74·7	54·	29·743	29·946	29·519	76	168	122									
1837,	66·9	72·8	54·6	·741	·999	·550	94	173	103									
1838,	64·1	74·3	53·4	·788	30·002	·593	53	223	97									
1839,	67·8	75·1	56·1	·771	29·999	·579	38	243	84									
1840,	67·1	76·5	46·7	·806	30·046	·644	37	234	95									48·48
1841,	68·	76·5	53·5	·786	·031	·482	42	214	99									59·78
1842,	67·9	76·8	56·9	·847	·056	·623	39	234	92									43·52
1843,	66·1	76·3	53·7	·721	·020	·625	38	221	106									78·73
1844,	68·2	77·6	57·	·851	·030	·632	35	243	88									45·91
1845,	67·1	76·7	51·4	·814	·083	·702	50	215	100									53·10
Mean for 10 ys	66·8	75·7	54·4	29·792	30·021	29·595	49·7	216·8	99·1	Mean depth of rain for 6 y'rs,								54·92

Remarks.

The foregoing tables are designed to show the mean, maximum, and minimum, of the Thermometer and Barometer, the number of clear, cloudy and wet days, the prevailing winds, and depth of rain, for ten years in the city of Natchez. These tables show clearly that the climate is good, and conducive to life and health, and all other blessings that heart can desire. With the exception of occasional epidemics, far between, Natchez is as healthy a city as can be found in the same parallel of latitude around the world, proved by the multitude and healthiness of the children; and where temperance, industry and good behavior are observed by the adult citizens, they are as healthy and long lived as in any part of the United States, let that part be where it may. Extremes of heat and cold, dry and wet weather are unknown. Injurious drought and heavy rains are rare. Within the last thirteen years, there have been eight destructive fires in the city, seven of which were followed by rain more or less heavy. These facts are mentioned as probable confirmation of Professor Espy's doctrine upon the subject; but whether true or not, let every one judge for himself.

Natchez, Aug. 12, 1846.

2. *Variations in the climate of France*; (L'Institut, No. 647.)—M. Dureau de Lamalle, in May last, read a memoir before the French Academy, in which he contested the value of the citations taken from ancient authors by M. Fuster adduced to prove that the mean temperature of France had diminished.

V. Astronomy.

1. *Atmosphere of the Moon;* (from an article on the Physical Constitution of the Moon, by Prof. E. Loomis, in the Sidereal Messenger, Cincinnati, i, p. 20.)—Whether we observe the moon with the naked eye or with the most powerful telescope, we have no difficulty in saying precisely where day ceases and night begins. The shadows of the lunar mountains are dark as midnight.—The transition seems instantaneous from midnight to noonday. We conclude that the moon has no twilight—or rather the legitimate conclusion is, that the moon has no twilight which can be appreciated by this mode of observation. More refined methods of observation have disclosed the existence of a feeble twilight. If there was no atmosphere, the line which joins the extremities of the horns of the new moon should pass exactly through the centre of the disc—that is, the ring of light should be an exact semicircle. By observing the moon when her phases were extremely falcated, Schröter discovered a faint glimmering light extending from both the cusps beyond the semicircle. The greatest breadth of this twilight was two seconds, corresponding to about two miles on the moon's surface.—We admit then that the moon has a twilight, extending about two miles in breadth, from which we compute that the height of the denser part of the moon's atmosphere is 1500 feet.

When the edge of the moon's disc approaches a star, the instant before its disappearance, its light must pass through the moon's atmosphere, if there be any, and suffer *refraction*. The light of the star, instead of moving in a straight line, must be bent behind the moon, and the star must be seen later than it would be without refraction. The contrary effect must take place at emersion; the star must re-appear sooner than it should if there were no refraction—in other words, the *duration* of an occultation is diminished by refraction. Now it is easy to bring this question to the test of experiment. We can compute the time required by the moon to move over a space equal to its diameter, and we have but to compare with this, the time of the star's disappearance. This observation has been repeated a thousand times, and the result is, that the two intervals are almost identically the same. For a long time it was considered doubtful whether there was any appreciable difference; but astronomers are now generally inclined to the opinion that there is a difference of a few seconds. This would indicate that the moon's atmosphere does refract light; but the effect is exceedingly small. The refraction produced by the earth's atmosphere is more than a thousand times greater than that of the moon. The pressure of the moon's atmosphere would be balanced by a column of mercury one forty-fifth ($\frac{1}{45}$) part of an inch in height. The best French air-pumps are warranted to rarefy air to one twenty-fifth ($\frac{1}{25}$) part of an inch of mercury. * * If we use language with the utmost precision, we must say the moon *has* an atmosphere; but to avoid being misunderstood, we should add, that *it is more rare than any we can produce with our best air-pumps.*

2. *On the Projection of a Star on the Dark Limb of the Moon just before its Occultation;* by Prof. Stevelly, (Rep. Brit. Assoc., 1845, p. 5.)—This the Professor considered to be a result of diffraction. Sir Isaac Newton having observed the shadow of a hair placed in a strong beam of sunlight to be broader than the hair itself, was led to investigate the course of a ray as it passed by the edge of a body, like the edge of a knife placed across a hole in the window-shutter, through which a sunbeam is admitted. Beyond a certain distance the rays proceeded in their usual straight courses; at that distance they were bent towards the edge; but the courses of the nearest rays were bent away from the edge, so as to form curves convex towards it. The undulatory theory enables us to trace these curves, and they are known to be of the nature of the hyperbola, with asymptotic branches extending onwards from the diffracting edge. Prof. Stevelly conceived the dark limb of the moon to be such a diffracting edge to the slender beam of light which reached us from a fixed star; and that as the curve was, at the last moment the light was allowed to pass, convex towards the moon, the portion of the ray which last enters our eye before the star disappears, being the direction in which we should then see the star, if produced backwards, would meet the moon on her dark surface.

3. *The Central Sun of the Universe.*—Prof. Mädler of Dorpat has announced that he has discovered the central sun about which our sun with its attendant planets performs its circuit. His conclusions are derived from a comparison of catalogues of stars since the time of Brad-

ley. The following summary may give some idea of the nature of his labors.

1. Of 15 stars in the group of the Pleiades, there is a great uniformity in the proper motions, and a general decrease of declination.

2. Of 12 other stars observed by Bradley within 5° of the Pleiades, the declinations have been generally decreasing since 1755.

3. Of 35 stars observed by Bradley from 5° to 10° distant from the Pleiades, the same remark is true.

4. Of 57 stars observed by Bradley from 10 to 15° distant from the Pleiades, the declinations are generally decreasing.

Out of 110 stars within 15° of the Pleiades, whose declinations are given by Bradley, we find—

60 motions towards the South;
49 motions very slow and yet undetermined;
1 ? towards the North.

Mädler explains these facts by ascribing to the solar system a motion nearly perpendicular to the ecliptic. He also remarks that the proper motions of the stars increase with their distance from the Pleiades, the greatest proper motions known (5 to 6″) occurring at a distance of about 90°. Mädler therefore concludes that the Pleiades constitute the central group of the system of fixed stars which compose the Milky Way, and that Alcyone is that particular star which is most probably the true *central sun.*

Alcyone, known also as η *Tauri*, or 25 *Tauri*, is a double star of the third or fourth magnitude in A. R. 3h. 38m.; Dec. 23° 39′ N.

Mädler estimates the distance of Alcyone from us to be such as light would require 537 years to traverse.

The time of one revolution of the sun about Alcyone he estimates at 18 millions of years. The mass of all the bodies whose distance from the central sun is not greater than our own, he estimates at 117 million times that of our sun.

Prof. Schumacher in giving place to this remarkable memoir in the Astronomische Nachrichten, intimates that he entertains some doubts respecting the conclusions—doubts which will probably be shared by many other astronomers.

4. *Antares.*—The announcement of the triplicity of the star *Antares*, at p. 280, was premature. It is probable that the appearance of the minute companion of a green color, is a result of prismatic dispersion; and that Antares is consequently a *double* star only.

5. *The new Planet Astræa.*—This newly discovered member of our system was followed at the principal European Observatories until it came too near the sun to be longer observed. The following are the

latest observations we have seen, and were made at the Berlin Observatory by Professor Encke.

May 12,	$9^h\ 57^m\ 46{\cdot}2^s$ m. t.	A. R. 100° 44′ 8·1″	Dec. + 21° 36′ 0·2″
13,	9 41 27·1 "	" 101 16 1·8	" 21 35 25·2
18,	10 20 27·2 "	" 103 59 44·4	" 21 30 56·2
22,	9 48 8·2 "	" 106 10 32.0	" 21 25 16·0

The following elements obtained by Mr. Graham of Markree Observatory, from observations of Dec. 17, Jan. 20, and Feb. 17, accord remarkably well with those obtained by Professor Encke from the first two weeks' observations.

Epoch 1846. Jan. 1·0.	Greenwich M. T.	
Mean longitude, .	94° 46′ 51·14″	
Mean anomaly, .	319 29 32·32	
Perihelion, . .	135 17 18·82	Mean equinox,
Node, . . .	141 16 59·46	1846, Jan. 1·0.
Inclination, . .	5 19 59·06	
Eccentricity, . .	0·1936831	
Semi-major axis, .	2·593452	
Mean motion, . .	849″·5508	
Revolution, . .	1525·5 days.	

It is gratifying to learn that Mr. Hencke has received various honorable testimonials for his discovery of this planet. The King of Denmark awarded to him a gold medal with the inscription, *Ingenio et Arti.* The King of Prussia also awarded to him a gold medal, and conferred upon him the order of the Red Eagle, IV, with an annual pension of three hundred dollars. E. L.

6. *Biela's Comet.*—In our May No. we have given some information respecting the extraordinary phenomena of this body. It was attended by a companion like a secondary comet, which was very remarkable for its changes of magnitude and brilliancy. This companion was noticed at Washington, Jan. 13, and this is the first notice of it we have seen from any quarter of the world, except the observation at New Haven, Dec. 29, 1845. At Cambridge, Eng., the phenomenon was first noticed Jan. 15th, though the first measurement of distance we have seen was for Jan. 23. On the 15th of January also, M. Wichmann at Königsberg noticed a faint nebula near the comet; and on the 26th, perceiving that the distance between the two bodies had changed, he commenced a series of measurements. At Naples the companion was first noticed Jan. 19; at Berlin, Jan. 27; at Geneva, Feb. 3; and at Dorpat, Feb. 13.

The following observations give the differences of Right Ascension and Declination of the two bodies. They were all made at Washington with the exception of the last two, which were made at Cambridge, Eng.

	Diff. A. R.	Diff. Dec.		Diff. A. R.	Diff. Dec.
Jan. 13,	about 4·0^{s}	1′ or 2′	Feb. 13,	8·6^{s}	4′ 38″
14,	4·0	1′ 18″	16,	9·7	5 4
18,	4·5	1 47	18,	9·9	5 17
19,	4·3	1 48	21,	11·7	5 52
22,	5·3	1 57	22,	12·1	6 4
23,	5·1	2 0	26,	14·8	6 48
24,	5·5	2 3	March 3,	19·4	7 35
26,	5·5	2 19	4,	21·4	8 11
28,	5·6	2 27	5,	22·5	8 7
Feb. 4,	6·2	3 10	8,	25·1	8 28
5,	6·5	3 21	10,	26·6	8 52
9,	7·1	4 1	14,	32·7	9 10
11,	7·7	4 1	21,	42·9	8 44
12,	8·0	4 29	25,	46·3	8 23
			27,	47·4	7 54

The following observations show the changes of brightness which the two bodies experienced.

Jan. 13th, the companion was first seen at Washington, but too faint for accurate measurement. It was estimated to have one eighth the magnitude and one fourth the intensity of Biela, or the main body. From this time, the companion increased rapidly both in magnitude and brilliancy. On the 12th of February the companion appeared the brightest, and on the 16th, the companion was estimated to be equal to Biela as to magnitude, but to have one third more intensity of light. On the 18th of February, Biela exceeded his companion at least two-fold both in magnitude and intensity of light. From this time the companion rapidly declined; and on the 3d of March it was estimated at one sixth of Biela. March 10th, the companion was estimated at one twentieth the brightness of Biela, and at Berlin it was pronounced too faint to be observed, although Biela was followed till April 24th. The companion was last seen at Washington, March 21st, and at Cambridge, Eng., March 27th, but "excessively faint."

The following notices of the physical appearances of these two bodies, as observed at Washington, will throw some light upon the nature of their connection with each other.

Jan. 14th, were noticed glimpses of a tail to each body; Biela's tail extending N. E., and his companion's nearly parallel with it.

Jan. 18. Tail of Biela only a few minutes of arc long, extending towards N. E., lancet like. Tail of companion not so long, but nearly parallel. Nuclei decidedly condensed towards the centre, but not resolvable into points of light except perhaps Biela's by glimpses.

Jan. 23. Companion has the appearance of two tails, one nearly parallel to Biela's, the other reaching over to his nucleus or rather just to the south of it.

Jan. 28. Biela exhibited a pointed nucleus; caught glimpses of a point of condensed light in nucleus of companion.

Feb. 4. A decided stellar nucleus to each comet, appearing like a sharp point of light. Tails reaching almost across the field and nearly parallel.

Feb. 11. The nucleus of companion decidedly stellar; that of Biela diffused, and by no means as bright.

Feb. 12. Glimpses of two nuclei in Biela; tail full one third across the field. Tail of companion nearly parallel with Biela's. Catch glimpses of another tail extending towards Biela just above a straight line between the two, and in a sort of arch. Appearance of two tails to Biela, second going off in a direction opposite from companion.

Feb. 21. Ragged condensation of light in nucleus of Biela. Both tails parallel, extending across the field.

Feb. 22. A band of nebulous matter, a little arched, joins the two. Appearance of a double nucleus about Biela. Has three tails radiating at angles of 120° to each other. The tail of Biela extends three times the field, say 45′.

Feb. 26. Biela has a tripod tail—the one extending opposite to the companion very distinct. Confused appearance about the nucleus of Biela as though there were several nuclei.

March 5. Companion has no apparent nucleus; is exceedingly faint, and without any mark of condensation.

March 8. One of Biela's tails points directly east—the other remains as it was.

March 10. No stellar nucleus to either comet. No tail to Biela by the moonlight.

March 14. Appearance of cometary fragments about Biela. Counted five of them in this position $\begin{smallmatrix} * \\ ** \\ ** \end{smallmatrix}$.

March 17. Companion is a very diffused mass of exceedingly faint nebulous matter. No appearance of fragments about Biela.

March 21. Companion very faint, muddy; a shining point in a dim patch of light about its nucleus.

March 30. Saw the two tails to Biela as formerly. Companion could not be seen.

From the preceding observations it probably will not be doubted that these two bodies had some connection with each other; that the one which we have called Biela was the main body; and that the companion was formed of matter which proceeded from Biela. The question then arises, how did the companion become detached from Biela. Was it by an internal explosion? Admitting the possibility of an explosion by which a cometary body might be torn into fragments, the rapid increase of size and brilliancy of the companion compared with Biela, from Jan. 13th to Feb. 16th, seems hardly explicable except upon the supposition of *a continued transfer of matter* from one body to the other for an entire month. It seems then most natural to suppose that the cause of this continued transfer was the same as that of the first formation of the companion. If this formation appears mysterious, we have at least observed phenomena in the case of other comets which possibly may have some analogy with this. Halley's comet at its last return was observed to emit streams of fiery matter, which presented the appearance of sectors of extreme brilliancy. The matter thus emitted from the head diffused itself in the direction opposite the sun, and formed the tail of the comet. The attraction of these particles of matter for each other was scarcely, if at all, appreciable. Suppose however the existence of a feeble attraction among these particles. A few of these collecting together would form a nucleus to which other neighboring particles would be attracted, and thus the particles emitted from the head would form a second nebulous body not unlike the companion of Biela. According to the rate of separation when first observed, these two bodies must have been together about the 1st of January. At this time then we may suppose Biela's comet to have commenced emitting particles from its head, which uniting by feeble attraction formed a small nebulous body. Perhaps when the repulsive force began to operate, it may have been for a time resisted by an envelop partaking somewhat of the character of a solid body; and when this resistance yielded, a considerable portion of the main body may have been at once detached by a sort of explosion. A fragment thus detached might attract to itself at least a portion of the stream of particles which continued to be emitted from the main body. Thus the companion increased at the expense of Biela until the 16th of February, which was soon after its perihelion passage. At this time the distance of the companion was such that it could no longer attract to itself the matter repelled from Biela. It therefore ceased to grow, and indeed appeared to decline in brilliancy, perhaps from the loss of matter which it emits in the same manner as Biela; although we have an example in the case of Encke's comet of a body which habitually becomes much less conspicuous after than before perihelion passage.

On the whole it must be admitted that the phenomena of comets are altogether anomalous. The comets of Halley, Encke and Biela, those of 1824 and of 1744, have exhibited phenomena which seem to require us to admit the existence of matter of a different kind from any thing we witness upon the earth.

E. L.

7. *Fourth Comet of* 1846.—The observations mentioned under this title (p. 138) appear to be memoranda referring to Biela's Comet.

The Comet discovered March 8, 1846, by *Brorsen* is identical with that discovered by *de Vico*, Feb. 20, 1846, and by Mr. *Geo. P. Bond*, Feb. 26.

8. *Fifth Comet of* 1846.—This Comet, whose perihelion passage occurred June 4–5, (see p. 138,) was first detected by *Brorsen*, on the night of April 30, 1846.

9. *Hind's Comet.*—A telescopic comet was discovered between the Camelopard and Cassiopeia, by Mr. *J. R. Hind* at Mr. Bishop's Observatory, Regent's Park, London, July 29, 1846, 11h. 10m., P. M. Its approximate place was, July 29, 12h. 6m. 6s., Gr. m. t. A. R. 3h. 15m. 35·2s.—N. Decl. 60° 37′ 2″.

The R. A. was diminishing and N. Decl. increasing.

Mr. Hind gives the following elements:

P. Pass., . .	1846, May 14·11425 Gr. m. t.	
Long. of Perihelion,	102° 43′ 56″	App. Eqx. July 30.
" " Asc. Node,	164 18 10	
Inclination, . . .	59 27 7	
Log. Perih. dist., . .	0.0628684	
Motion, ...	retrograde.	

10. *Le Verrier's Planet.*—The new planet, whose existence M. Le Verrier demonstrated mathematically from the inequality in the motions of *Uranus*, was actually discovered by M. Galle of Berlin, Sept. 23d, 1846. This grand discovery is announced in a letter from Dr. Brünnow of the Royal Observatory at Berlin, dated Sept. 25th. He says, "the planet resembles a star of the 8th magnitude, but with a diameter of two or three seconds. Its motion is now retrograde, at the rate of four seconds of time daily. Below are two of its places :—

Sept. 23, $12^h\ 0^m\ 14^s{\cdot}6$ m. t.	R. A. 328° 19′ 16″·0	S. Decl. 13° 24′ 8″·2
" 24, 8 54 40 ·9 "	" 328 18 14 ·3	" 13 24 29 ·7

Mr. Hind at Mr. Bishop's Observatory, Regent's Park, London, observed the new planet Sept. 30, notwithstanding the moonlight and hazy sky, and with a power of 320 he saw the disc. Its place was Sept. 30, $8^h\ 16^m\ 21^s$ Gr. m. t. R. A. $21^h\ 52^m\ 47^s{\cdot}15$. S. Decl. 13° 27′ 20″.—*Lond. Athenæum, Oct.* 3.

VI. Miscellaneous Intelligence.

1. *Improvement in the construction of the Rails and Wheels of Railroads.*—Mr. C. H. Greenhow of London has published a pamphlet in which he condemns flanged wheels, and recommends circular rails and concave tire as much better adapted to the ever varying circumstances of a long line—such as curves, loose chairs, sprung rails, &c.

2. *Manufacture of Gas for illumination, from Water.*—M. Jobard has succeeded in giving to hydrogen a high illuminating power; the gas burns with a white and brilliant flame equal to thirty six candles of six to the pound.

This gas was charged with carbon by passing it through a cylinder containing about two quarts of oil of gas tar; but as the gas deposited its mechanically suspended carbon, M. Jobard caused hydrogen gas obtained by the distillation (decomposition?) of water to take up hydrocarburets produced by the distillation of coal gas at the moment of formation: twice or thrice as much gas could be obtained as by the ordinary method, and the gas needed no purifying, especially when fish or other oils were employed.

The combined gases contain carburets of hydrogen, 57; oxide of of carbon, 28; and free hydrogen, 15. One hundred and eleven feet of gas were produced from every pound of oil.

3. *Board of Regents of the Smithsonian Institution.*—The following persons constitute the Board of Regents of the Smithsonian Institution. The Vice President of the United States. The Chief Justice of the United States. The Mayor of the city of Washington. Messrs. Evans, Pennybacker, and Breese of the Senate. Messrs. R. D. Owen, W. J. Hough, H. W. Hilliard, of the House. R. Choate, Mass., G. Hawley, N. J., Richard Rush, Pa., William C. Preston, S. C., A. D. Bache, and J. G. Totten of Washington.

Preparations are making to go on at once with the erection of buildings, and the organization of the institution.

4. *Wollaston Medal.*—The Wollaston Medal has been presented by the Geological Society of London to Mr Lonsdale, well known for his various contributions to Palæontology, and especially in the difficult department of fossil corals.

5. *Geological Society of France;* (L'Institut, No. 655, July 2, 1846, p. 252.)—This society held its annual session at Alais (Gard), on the 30th of August, this place being selected on account of its great Geological interest, as it combines the richest coal beds of France, mines of iron and lead, the jurassic formation and the lower cretaceous.

6. *Prof. Louis Agassiz.*—This distinguished European naturalist arrived at Boston about the first of October. We learn with pleasure that he will spend several years among us, in order thoroughly to understand our natural history. M. Desor, his companion in the glaciers of Switzerland, and Mr. Dinkel, the artist of his beautiful plates, are soon to join him in this country.

7. *M. de Verneuil* has left for Paris, but will again return after a year.

8. *The Ray Society.*—We call attention to the prospectus of this useful society, which will be found among our advertisements.

9. *The Association of American Geologists and Naturalists*, held its seventh annual session at New York, as previously announced, on the 2d of September and the week thereafter. We publish in the present number of this Journal, two papers which were read at this meeting; and further notice of their doings will be given on another occasion.

10. *The British Association* met at Southampton on the 10th of September, under the direction of Sir Roderick I. Murchison. We understand from a gentleman who has been present on several previous occasions, that this meeting was one of uncommonly high character. Their proceedings have reached us through the kindness of Mr. Lyell, but too late for notice in this volume.

11. *Museum of Economic Geology in Great Britan;* (from the Anniv. Address by L. HORNER, Esq., before the Geol. Soc. of London, Quar. Jour. Geol, p. 152.)—In his Anniversary Address of 1840, Dr. Buckland adverted to the recent establishment, by the Government of that time, of the Museum of Economic Geology. It not only received encouragement from their successors, but has been placed by them on a more enlarged and comprehensive plan. During the last year the Geological Survey of Great Britain and Ireland has been transferred from the direction of the Master General of the Ordnance to that of the Chief Commissioner of her Majesty's Woods and Works; and that Survey and the Museum of Economic Geology are now united under one management. The establishment is supported by an annual parliamentary grant, which in the last session amounted to 8850*l*., including the Museum of Economic Geology in Dublin; and large premises are about to be built by Government in a central part of the metropolis for the accommodation of the several departments, the extension of the Museum, and the accomplishment of other useful plans that are in contemplation. It is a reproach to former Governments that the formation of such an institution should have been left to recent times, in a country deriving so much wealth, importance and power from its mineral treasures.

When we consider the high qualifications of the officers selected by the Government for carrying out this scheme, we may look forward with confidence to their rendering important services to geological science, as well as to mining interests, the arts and manufactures. Sir Henry De la Beche is, as you are aware, the Director-general; and his indefatigable zeal and exertions, and above all the judgment shown by him in his recommendations of the other officers, cannot be too highly estimated. Mr. Andrew Ramsay is Director of the Survey of

Great Britain; Captain James, of the Royal Engineers, is Director of that of Ireland; Professor Edward Forbes is Palæontologist, and Mr. Warrington Smyth, Mining Geologist for the United Kingdom; and there is reason to believe that Dr. Hooker will be appointed to the department of Botany.* Mr. John Phillips is engaged in the Survey of the North of England, and one laboratory of the Museum of Economic Geology is under the direction of Mr. Richard Phillips, one of the founders of this Society, and another under the direction of Dr. Lyon Playfair. There are besides several able officers in different departments.

Bibliography.

1. *The Sidereal Messenger, a Monthly Journal, devoted to Astronomical Science.* 4to. Monthly. 8 pp. each, with engravings. Cincinnati, O. Price $3 a year.—Prof. O. M. Mitchel, the able and enterprising director of the Cincinnati Observatory, has undertaken a periodical work, whose title we have cited above. Its object, as stated in the prospectus, is "to record in a plain and simple form, the results of the researches made with the great achromatic refractor of the observatory,—to present the earliest astronomical intelligence from all parts of the world,—to furnish to our countrymen, in their own language, the most interesting articles from foreign astronomical journals,—to excite an interest among the people in the elevating study of astronomy,—and to give a permanent support to the Institution under whose auspices the publication is made." Four numbers are already issued, containing the articles named below, besides various other interesting notices.

Account of the Cincinnati Observatory, and the Great Refractor.
Telescopic View of the Moon.
Account of Biela's Double Comet.
Maedler on the Central Sun.
Prof. Loomis on the Physical Constitution of the Moon.
Extraordinary Phenomena observed during the Total Eclipse of the Sun, July 7, 1842.
Orbitual Motion of the Double Stars.
Observations on Double Stars, made with the Cincinnati Refractor.
Letters from Eminent Foreign Astronomers.

This Journal, the first on our Continent, devoted solely to astronomy, promises to be highly useful to the science of the country, and reflects great credit on the city of its birth. We trust it will be liberally supported.

2. *The Trees of America, native and foreign, pictorially and botanically delineated, and scientifically and popularly described, etc., illustrated by numerous engravings;* by D. J. Browne, New York, 1846, Harper & Brothers. 1 vol. large 8vo, pp. 520.—This is the work of a

* Dr. Hooker's appointment has since taken place.

person truly fond of his subject, and who has evidently devoted no little attention to it. The wood-cuts are pretty good, the typography and paper are handsome, and the volume contains much well selected and some original popular matter. The author leaves us in much doubt as to the extent of the field he means to embrace. Though we find no statement restricting the general title "Trees of America," we presume, on the whole, that those of the United States only are intended which may be termed *par excellence* American, in the same way that the continental title is applied to our citizens abroad. What is meant by the "*foreign* trees of America," is not so clear, since Mr. Browne has omitted many of the common hardy exotics cultivated among us, while he has given such as the *Pistachio-nut*, the *Paraguay Tea*, the *Prunus avium*, of Europe, (which stands in his book under the name of "The Wild Cherry tree," to mislead the general reader,) the *Laurus nobilis*, or True Laurel, and lastly the *Camphor-tree*, which is surely "foreign" enough. On the other hand, the greater part of our Thorns, our wild Crab-trees, the Southern Prickley Ash, two of our Rhododendrons, and a large portion of our commonest taller shrubs are entirely unnoticed; not that shrubs do not fall within the range of the work; for the low Canadian Barberry, the *Æsculus macrostachya* and the *Ilex vomitoria*, &c., are given in full. Upon examination we find the book closes abruptly with the Elm family; the Amentaceous and Coniferous trees, that is, *our principal forest trees*, being left to the contingency of another "supplementary volume," to be published or not, as circumstances may warrant;—which we suspect is not exactly according to the terms of subscription. We should not have remarked upon this, nor upon the singular notion of making the Oaks, Hickories and Pines play a *supplementary* part to Oranges, Almonds, Pomegranates, Myrtles, Figs and Camphor-trees, in a work on the "trees of this country more complete and extensive than had hitherto been published," if there had been any indication upon the title-page or cover, or even an explicit statement in the preface, that this is only the first volume of a work on our trees, and in itself incomplete. This is "a trick of the trade," for which perhaps the author himself is not directly responsible. That we do not consider Mr. Browne as high botanical authority will not be surprising, when it is seen that he describes the *Ohio Buckeye* as a variety of the *common Horse Chestnut*, the *Rhus glabra* as a variety of the *Rhus typhina*, the *Robinia hispida* or *Bristly Locust* as a variety of the *pseudacacia* or common Locust-tree; states his confident belief that the *Choke Cherry* and the *Wild Black Cherry* (*Cerasus virginiana* and *C. serotina*) are one and the same species; confounds in the same way all our species of Ash under *Fraxinus americana*, and all our Elms, even the *Wahoo*, and *Slippery Elm*, under *Ulmus amer-*

icana. Some of these mistakes are copied from Loudon; but an American writer on the trees of his own country, who professes to exercise his own judgment on these points, should have corrected such obvious errors, instead of adding to them. Some liberty is taken with the poetry as well as the botany. A part of those beautiful lines—

> "Wise with the lore of centuries,
> What tales, if there were tongues in trees,
> Those giant oaks could tell,"—

are "conveyed" to the Pittsfield Elm, without a sign to indicate the change. The fruit of *Cratægus spathulata* is said to be of "the smallness of a grain of mustard-seed, (p. 274.) The venerable Hales is said to be the author of "Vegetable Statistics"—instead of *Vegetable Statics.* Mr. Browne, following Michaux, says, "The wood of *Olea americana* is excessively hard, and difficult to cut and split: hence the provincial name of *Devil-wood*," (p. 382.) An insufficient reason, one would think, for the bestowal of such an ungracious cognomen. We have heard a better and more probable explanation,—viz. that the wood in burning snaps loudly, throwing the fragments explosively from the hearth. We should like to know our author's authority for the following curious statement respecting the Sassafras-tree. "The most interesting historical recollection connected with this tree is, that it may be said to have led to the discovery of America; as it was its strong fragrance smelt by Columbus that encouraged him to persevere when his crew were in a state of mutiny, and enabled him to convince them that land was not far off," (p. 417.) Acute olfactories the great navigator must have had, to snuff the fragrance of Sassafras groves in Florida, more than five hundred miles off! Besides, now-a-days, the flowers of Sassafras are almost scentless. With the greatest propriety does the author say that he "feels called upon to acknowledge that he is particularly indebted to Mr. Loudon *for a large share of his work*, taken from the Arboretum Britannicum, and to Dr. Thaddeus W. Harris, for many valuable extracts from his Report on the Insects of Massachusetts injurious to vegetation." From the latter copious abstracts of the highest interest have been very freely taken; indeed nowhere, beyond Dr. Harris's own volume, will so large an amount of his invaluable researches be found embodied, as in Mr. Browne's work.

A. Gr.

3. *Outlines of Structural and Physiological Botany;* by Arthur Henfrey, F. L. S., etc. With numerous illustrations. In three parts. Part I, Elementary Structures. Part II, Organs of Vegetation. pp. 106, 12mo. London, 1846. Van Voorst.—The third part, "containing the Organs of Reproduction and General Physiology," is doubtless by this time published, completing this compendious but exceedingly

useful treatise. Its particular object, the author informs us, is to "put the student in possession of the results of the numerous and important researches which have been published within the last few years in this department of science," especially by the German observers, who are prosecuting their investigations in vegetable anatomy with such zeal and success, researches which, scattered as they are through various journals, or contained in voluminous works, and to a great extent locked up in a foreign and difficult language, are placed quite "beyond the reach of many who are interested in them, especially of those whose time is so valuable as that of medical students." This little work accordingly is very valuable as a summary of the most recent views and discoveries in vegetable structure, giving special prominence to the formation and metamorphosis of tissues, the phenomena of growth, &c. It is not a mere compilation, but a careful digest, evidently prepared by one who is thoroughly conversant with his subject; the topics are admirably arranged, and the results succinctly and for the most part very clearly stated. Without waiting for the concluding part, therefore, we may unhesitatingly commend this little treatise to the general, and especially to the medical student. Compendious as it is, we know of no work in the English language which gives so much information upon vegetable anatomy in such a small compass, or so well exhibits the present state of knowledge and opinion upon this class of topics. A. Gr.

4. Delessert, *Icones Selectæ Plantarum quas in Prodromo Syst. Nat. ex herb. Parisiensibus, presertim ex Lessertiano, descripsit, Aug. Pyr. DeCandolle*, Vol. 5, 1846, (100 plates, folio.)—The fine illustrated work for which botanists are so greatly indebted to Baron Delessert, has just reached its fifth volume. The principal families here illustrated, are the Lobeliaceæ, Ericaceæ and Epacrideæ, Myrsinaceæ, Sapotaceæ, Styracaceæ, Apocynaceæ, and Asclepidaceæ. The following plants of our own country are figured, viz. *Dipholis salicifolia*, a Sapotaceous tree which we believe is found at Key West; *Enslenia albida*, without the fruit; and *Podostigma pubescens*. Having recently noticed the interesting volume which M. Lasègne has devoted to an account of the immense herbaria and almost complete botanical library of Baron Delessert, we may take this opportunity to state that Prof. Alph. DeCandolle has made it the subject of a very instructive review, in a late number of the *Bibliothèque Universelle*, of Geneva.

A. Gr.

5. *A Text Book on Chemistry, for the use of Schools and Colleges*; by John William Draper, M. D. Harper & Brothers, 1846. 12mo, pp. 408.—This text book follows the same order of arrangement which Prof. Draper has been accustomed to adopt in his lectures. It is terse, lucid and philosophical, and appears to be well adapted to the object for which it is published.

6. *Adulterations of various Substances used in Medicine and the Arts*, with the means of detecting them; by LEWIS C. BECK, M. D. New York, S. S. & W. Wood, 1846. 12mo, pp. 332.—Following an alphabetical arrangement, Dr. Beck has presented in the present volume much valuable information on all the common articles of commerce and medicine which are known to be adulterated, as well as on many which are more rare. He has also pointed out the mode of detecting the adulterations by the application of proper chemical tests. The practical usefulness of this volume sufficiently recommends it.

7. *Observations in Natural History*, with an Introduction on Habits of Observing as connected with the Study of that Science, &c. &c.; by the Rev. LEONARD JENYNS, M. A., F. L. S., etc., Vicar of Swaffham Bulbeck. London, J. Van Voorst, 1846. 12mo. pp. 440.—This scrap book is made up in a diary form, of the notes of interesting facts in Natural History observed by the worthy vicar and collector during the past twenty years. They embrace a great variety of subjects, and are written in the same flowing easy style which made White's Selborne one of the favorite companions of our youthful days. The volume is introduced by a chapter on habits of observation, and the value of such habits is well enforced by the silent example of the Rev. Jenyns, whose intervals of parochial duty have been filled with the varied pleasures which nature always awards to her votaries. This volume is closed by a calendar of periodic phenomena in natural history, with a chapter on the importance of such registers.

8. *A Monograph on Fossil Crinoidea;* by THOS. AUSTIN, Esq., F. G. S., and THOS. AUSTIN, Jr., Esq., A. B. J.—This work is now publishing in numbers, of which the first five have reached us through the attention of the authors. It is in quarto, each number being illustrated by two elaborate plates drawn from the best specimens and fully described. The work will be complete in about twenty parts, at 3s. 6d. each, and is published by subscription by J. Tennant, 149 Strand, London.

9. *The Brain and its Physiology, &c.;* by DANIEL NOBLE, member of the Royal College of Surgeons, London. J. Churchill, London, 1846. 8vo, pp. 450.—The object of this volume—which is ably written—is to support the doctrines of Gall and Spurzheim by anatomical and physiological proofs.

LIST OF WORKS.

Descriptiones Animalium, quæ in itinere ad maris Australis terras per annos 1772–74 suscepto collegit et delineavit, J. R. Foster, nunc demum editæ impensis Academiæ Berolinæ, curante H. Lichtenstein. Berlin, 1844, in 8vo, pp. 424.

Iconographia familiarum naturalium regni vegetabilis auctore A. Schnizlein. Bonn, Fasc. iv, 1846.

Voyage dans l'Inde, par Victor Jacquemont, pendant les années 1828–32, publié sous les auspices de M. Guizot. Paris.

Taylor's Memoirs, part xvi, (nearly ready,) containing, *Müller* on the structure and characters of the Ganoids and on the classification of Fishes.—*Regnault* on the Elastic Forces of Aqueous Vapor.—*Regnault's* Hygrometrical Researches.—*Berzelius* on the Composition of Organic Substances.—*Fresnel* on the colors produced in homogeneous fluids by polarized light.

Transactions of the Linnæan Society of London, vol. xx. 1*l.* 10*s.*

Correlation of Physical Forces, by W. B. Grove, Esq., royal 8vo, *London*, 1846.

Voyages de la Commission Scientifique du Nord en Scandinavie, en Laponie, au Spitzberg et aux Feroë, pendant les années 1838, 1839 et 1840, sous la direction de M. Gaimard. *Paris.* The 40th livraison has appeared. The work will form 20 volumes in 8vo, and 7 folio atlases, containing 516 plates.

Nouvelles Annales des Voyages et des Sciences Geographiques, redigées par M. Vivien de Saint-Martin; 5e serie, 2e année, 1846. *Paris.*

Zweiter Supplement zu der Handwörterbuch der chemischen Theils der Mineralogie, by C. F. Rammelsberg. 8vo, *Berlin.*

Grundriss der Chemie, by M. Wöhler, 8th ed. in 8vo. Berlin.

Naturgeschichte der Infusionsthiere; by Prof. S. Kutorga, with an Atlas. St. Petersburg, 1839; in German, 144 pp. 8vo, and 4to atlas, Carlsruhe, 1841.

Thesaurus Literaturæ Botanicæ omnium gentium; G. A. Pritzel. Leipsic. Announced for 1847, by F. A. Brockhaus.

SCIENTIFIC RESEARCHES.

Annals of the Lyceum of Natural History of New York, Vol. iv, Nos. 6, 7. August, 1846.—p. 171. Description of a new species of Anser (A. nigricans) with a plate; *G. N. Lawrence.*

p. 172. A Descriptive Catalogue of the Geodephagous Coleoptera, inhabiting the United States east of the Rocky Mountains; with two plates; *John L. Le Conte.* In connection with the Catalogue there are descriptions of species of the following genera: Cicindela, Galerita, Cymindis, Calleida, Axinopalpus (nov. gen.), Dromius, Lebia, Coptodera, Thyreopterus, Brachinus, Dyschirius, Clivina, Pristodactyla, Rhadine (nov. gen.), Anchomenus, Agonum, Olisthopus, Pæcilus, Adelosia, Stereocerus, Argutor, Piesmus (nov. gen.), Lyperus, Feronia, Steropus, Broscus.

Annals and Magazine of Natural History, *August*, 1846, *No.* 117. Notices of British Hypogæous Fungi; *M. J. Berkeley* and *C. E. Broome.*—Regular Arrangement of crystals in certain organs of Plants; *E. J. Quekett.*—Remarks on certain genera belonging to the class Palliobranchiata; *W. King.*—Excursions in Upper Styria; *R. C. Alexander.*—Birds of Calcutta; *C. J. Sundevall.*—Structure of Cucurbitaceæ; *J. E. Stocks.*—Ornithology of Tobago; *W. Jardine.*—*Zoological Society, March* 24, 1846. New species of shells; *J. H. Jonas.*—April 14. Twenty new Helicea, in the collection of H. Cumming; *L. Pfeiffer.*—*June* 9. Three new Trochilidæ; *Mr. Gould.*—*June* 23. On the Dinornis; *R. Owen.*

September, No. 118. Growth of cell-membrane; *H. v. Mohl.*—Generation of Ixodes; *Prof. Gené.*—Description of 13 species of Cephalopus in the Brit. Mus.; *J. E. Gray.*—Birds of Calcutta; *C. J. Sundevall.*—Four new genera of Crustacea; *A. White.*—New genus of Arachnida, family Attidæ; *A. White.*—New Mammalia (Herpestes, Felis, Pteromys and Jacchus); *J. E. Gray.*—Two new Antelopes; *J. E. Gray.*—*Linnæan Society, Feb.* 17. Axial and ab-axial arrangement of carpels; *T. S. Ralph.*—Caricis species nov., &c.; *Dr. Boott.*—March 17. Siliceous armor of Equisetum hyemale; *Golding Bird.* *Ap.* 21. Development of Starch and Chlorophylle; *E. J. Quekett.—Zoological Society, July* 14. Forty new species of Haliotis, in the collection of H. Cuming; *L. Reeve.*—Fifty-four new species of Mangelia, in the collection of H. Cuming; *L. Reeve.*

ANNALES DES SCIENCES NATURELLES, February, 1846.—*Zoology.* On the respiration in birds; *N. Guillot.*—On the Capra padu and Equus bisulcus of Molina; *MM. Gay* and *Paul Gervais.*—On the typical differences, hitherto unknown, in the organs of the voice in the Passeres; *J. Müller.*—Monograph on the Tergipes Edwardsii; *A. de Nordmann.—Botany.* Action of light on roots, by *M. Durand,* reported on by *A. Brongniart* and *Dutrochet.*—On the development of the ovule and embryo in the Schizopetalon Walkeri; *M. Barnéoud.*—Researches on Crustacea; *Dr. Pfeiffer.*—Revision of the genus Iris; *E. Spach.*—On the Fungi of the Museum at Paris; *J. H. Léveillé.*

March.—Zoology. On the Tergipes Edwardsii; *A. de Nordmann,* (continued.) Note on the development of the Chelonia; *H. Rathke.*—On the development of the Spermatozoids of the Ray and Torpedo; *M. de Martino.*—On the mechanism of the secretions; *A. Lereboullet.*—On the temperature of the Spatangus purpureus, Trigla hirundo and Gadus æglefinus of the Northern Seas; *Ch. Martius.*—On the testicles and spermatozoids of the Patellæ; *Lebert* and *Robin.—Botany.* On the Fungi of the Paris Museum; *J. H. Léveillé.*—On the composition and structure of several organs of plants; *Mirbel* and *Payen.*—On the absorption of arsenic by healthy and living plants; *A. Targioni-Tozzetti.*

April.—Zoology. On the composition and structure of the envelop of the Tunicata; *Lœvig* and *Kalliker.*—Report on the same; *Payen.*—Researches on Zoophytes; *Dana.*—On different species of fossil mammifera of the south of France; *P. Gervais.—Botany.* On the organization of the Myrodendron; *J. D. Hooker.*—On the temperature of 1846, and its influence on the flowering of plants; *C. Martius.*—Monograph of the genus Cardopatium; *E. Spach.*—On the anatomical structure of the Cuscuta and Cassytha; *J. Decaisne.*—On the Fungi of the Paris Museum; *J. H. Léveillé.*

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