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AND

JAMES D. DANA,

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CONTENTS OF VOLUME XIX.

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SCIENTIFIC INTELLIGENCE.

NUMBER LVI.

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THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. I.—*Account of some Volcanic Springs in the Desert of the Colorado, in Southern California;* by JOHN L. LECONTE, M.D.

IN October, 1850, being at Vallecitas, San Diego Co., California, it was my good fortune to make a visit, in company with Major Heintzelman and Mr. Matsell, to certain boiling springs, not similar to any which have been noticed in our territory; and as the only account yet given of them has appeared in a newspaper, it seemed to me, that the rough notes taken while making the visit, might with slight changes be of interest to my scientific friends.

Mysterious accounts had been given us of a 'Volcan' situated in the midst of a plain covered with salt, near the shore of a lake: and although most of the salt used by the inhabitants of the mountains east of Santa Isabel was brought from this lake, no very definite account either of the distance of the lake, or of the phenomena to be seen there, could be procured. It was only apparent that some awe-inspiring object had heretofore defended itself against the prying curiosity of man.

Major Heintzelman, then in command of the troops about to be stationed at the Gila river, having determined to visit these objects of unknown interest, kindly offered me an opportunity of joining his party.

Having secured as guides the interpreter from Santa Isabel, and the head chief of the 'Lleguina' Indians living near the Salt Lake, we left San Felipe a short time after the rising of the moon on the morning of the 28th of October.

Entering almost immediately a small cañon, by which we ascended a rocky ridge, we soon descended again into a narrow deep cañon trending N.E.; this we followed for several miles, encountering in our route many precipitous places, over which we had great difficulty in leading our horses. The rocks were metamorphic, of a gneissoid and sienitic character, and the scanty vegetation was similar to that of Vallecitas; the most conspicuons objects being Larrea mexicana, Fouquiera spinosa, Prosopis, Agave and a variety of brittle and uncouth looking Opuntiæ, both of the flattened and cylindrical forms.

The cañon finally entered a long valley, in which were remains of some Indian huts, now abandoned from the failure of water.

The valley opened abruptly by a gap through the most eastern mountain range, and at 8 A. M. we found ourselves on the edge of the great desert, though still considerably above the general level of its surface. An extensive but peculiarly uninteresting prospect was before us; an immense plain extended to the eastern horizon, broken towards the north by some slight inequalities; masses of rock lay around us on the mountain side; the mountain itself, appeared a wall of naked rocks, and it was only within a small circle of vision, that an earth colored vegetation could be observed; as if the influence of our own living selves had communicated a fictitious vitality to the spot where we stood, which soon would depart with us, and leave the ghosts of plants to shrink again into the rocks from which they had been evoked by our presence.

At an indefinite distance towards the N. E. was seen a low range of mountains, near which a silvery surface with a slight fog resting over it seemed to indicate water. This the guides declared was the Salt Lake, on the shores of which were the objects of our search, and confidently assured us that we should reach it before night.

Halting here for breakfast, some excellent capon, and hard bread, washed down with a limited draught from our canteens soon prepared us for the dreary ride; the only resources to shorten the way being very limited geology, and as may be inferred from the nature of the country, equally poor botany. It is no wonder that Government reports abound with names of plants, which suggest nothing but linguistic difficulties, for there is little else in the vast deserts of Western America to occupy the attention of the intelligent traveller; and with the determination of one resolved to struggle with the dull sublimity of inorganic matter, he frequently breaks off and preserves a piece of some hideous vegetable, whose only charms are the ugliness of its form, the lifelessness of its color, and the apparent absence of flower, and foliage, and every thing else that renders a plant attractive.

Overlying the metamorphic rock was seen a conglomerate of great thickness, similar to that which at Vallecitas forms the greater portion of the eastern range of the Sierra: boulders frequently of immense size, but scarcely rounded, torn in former ages from the adjacent ranges of mountains, are cemented together by a small quantity of calcareous matter enveloping gravel of different degrees of fineness: this cement presents somewhat the appearance of bad mortar. Outside of this conglomerate was seen unstratified drift. Beyond the mountains, can be traced on the desert a tertiary formation similar to that of San Diego, and above this stratified drift. These formations are nearly horizontal and form low ridges. The vegetation was still similar to that of Vallecitas, with the addition of a very large Echinocactus, of which several grew occasionally from one base: Opuntia vaginata was also seen, and an Ephedra appeared with a species of Koeberlinia. These gradually faded out, till at last nothing remained but Prosopis, Larrea, and a plant at that season leafless. The desert contains three principle levels; of these the upper (consisting of the part near mountain ridges) is covered with gravel, small stones from the mountains, silicified wood and oyster shells; the middle level is sandy, and the lower one clayey, with great numbers of fresh water shells scattered over its surface: among these the only bivalve is a species of Anodon, now found in the Colorado River, (A. californiensis *Lea*); the other species are small univalves, belonging to Physa, and Amnicola. These clayey parts extend for many miles, and are evidently the beds of lagoons, which on rare occasions may be filled with water; they belong to the New River system of overflow, hereafter to be described. Having travelled from the mountains a nearly east course, we encamped about 4 P. M. on the bank of a small stream running northwardly to the Salt Lake: the banks were precipitous, about twenty feet in height, and the waters disagreeably saline. This stream is evidently Cariso creek, which being lost in the sands a few miles from its source here reappears on the lower level of the desert: some rushes growing on the edge of the water furnished food for our horses.

Starting the next morning at 3 A. M. we arrived about 10, at an Indian village situated on New River, which is here near its termination, and probably when the supply is abundant, sends a portion of its water to the Salt Lake: at present there are only two or three small pools near the village.

New River is an important object to those compelled to cross the desert, since from it is derived the chief supply of water, to be found between Cariso creek and the Colorado. It is in reality a slough of the latter, which is only different from the ordinary sloughs near the river by its greater length, extending by a very tortuous course 70 or 80 miles from the point where it leaves the river. The bed of the Colorado, like that of other rivers carrying a large amount of sediment, is above the lower portions of the adjacent country, which are thus, in time of overflow supplied by these sloughs; frequently however the annual rise of the river is not sufficient to supply New River with water, and should this occur for two years in succession the lagoons along its course become entirely dry, and the difficulty of crossing the desert is much increased.

The whole course of New River is marked by a large species of Chenopodium, called 'Kelite' by the natives, and 'careless weed' by the emigrants; it furnishes almost the only food for cattle and horses to be found in this region: the seeds are used by the Indians in preparing a kind of cake, which is quite palatable, when nothing else can be procured. The green leaves (if they ever are green) may be used as a salad, or boiled as a vegetable.

The ground passed over before arriving at the village was in many places covered with a thin layer of sandstone, forming occasionally concretions like claystones; this sandstone has apparently been formed by springs similar to those seen afterwards. The dust was sometimes extremely fine and incoherent, so that the feet of the horses would sink from six to eight inches; many pieces of pumice were also found stranded on the surface.

The Indian village contained about fifty inhabitants, who received us in a very friendly manner, offering us melons, beans and pumpkins, which they raise in abundance. Visiting the village were some Yumas from the Colorado, who recounted to Major Heintzelman the depredations committed by the grand army of California, recently sent under one Major General Morehead, to avenge the murder of a party of ferrymen at the junction of the Colorado and Gila. Though these depredations were not remarkable, the Indians had apparently had enough of the war, and learning that a military post was soon to be established, they became very anxious to make peace, until another opportunity for safely committing some outrage should occur.

After resting our horses, we started with an escort of seven or eight Indians, who used all the power of their eloquence to dissuade us from going. Nevertheless, on our exclaiming that we had come a long distance to see these volcanoes, and that we would seek them for ourselves, if they were afraid to accompany us, the debate ceased, and we rode on in a northwesterly direction. After going about eight miles, we reached a soft muddy plain bordering the Salt Lake: the salt in consequence of a recent shower had almost disappeared, only a few crusts about half an inch thick now remaining. The deposit is said to be sometimes a foot in thickness.

North of the lake, and now distant from us six or eight miles, is a chain of rocky hills 800–1000 feet high, portions of which have a volcanic appearance. Rising from the plain, where we now stand, are several volcanic mounds about 100–150 feet high; hastening to one of these, I found it composed of lava, and pumice: several of these mounds are arranged in an arc of a circle, but the general direction is a little west of south.

Having arrived thus far, and given our horses in charge to some of the Indians, the interpreter again endeavored to dissuade us from further exploration. He said that on approaching the springs, the steam from which was now distinctly seen, devils in the shape of large black birds rose from the ground, and descended with overwhelming force on the head of the rash adventurer: he stated that a tradition still existed among the Indians, of one Juan Lonquiss (Longecuisse? perhaps a "Crapaud" trader) who had met this dreadful fate, and asked us in a pathetic tone, how he could return to his town, if we too were sacrificed in this way. We replied, in substance, that devils had no power over us, and that we were stronger than they, and that probably they were aware of that fact, and would not appear during our visit.

This seemed very blasphemous to their ears, and the whole escort suddenly dropped behind, leaving us to our fate.

Advancing towards the place, whence the steam issued, we found in the muddy plain numerous circular holes containing boiling mud, and exhaling a naphtha-like odor. Many of them are encrusted with inspissated mud, forming cones 3–4 feet high, from the apex of which proceed mingled vapors of water, sal-ammoniac and sulphur. Four of them eject steam and clear saline water, with great violence, resembling in appearance the jet from the pipe of a high-pressure engine. The falling spray around these has formed a group of acicular stalagmites, composed of aragonite with a small quantity of silica and some saline matter: many of these stalagmites are tubular in form. Another spring was a large basin filled intermittingly to overflowing with foam and clear saline water: around the edge were botryoidal masses of aragonite, like that forming needles around the cones. Near the cones, in little fissures, were crusts of sal-ammoniac,* some of which were colored red, possibly by sulphuret of selenium.

The Indians, finding that the black devils did not assail us, ran up to us, with great exultation, and leaped about, and danced in such an extravagant manner, that we were obliged to caution them of the danger of breaking through; the solid crust was evidently very thin, as it bent and trembled under our weight in a very threatening manner.

In returning we found on the most northern of the volcanic mounds before mentioned a quantity of scoria and obsidian, and distinctly traced the course of a lava stream down the side. The mounds all showed traces of aqueous action, in the terrace-like manner in which the pumice was arranged. The rest of our

* The specimens of saline crusts having been subsequently lost, I cannot be certain that they were really sal-ammoniac, and only refer them to that salt from the sharpness of their taste.

course to the Indian village was unmarked by any incident worthy of note. The next day about 12, having taken a supply of musk-melons as our only food, we started for Vallecitas. The afternoon was windy, and, a rare phenomenon in this region, showery. About nine or ten miles from the village, we passed some mounds covered with cinders and pumice, and on the top of one of them found a crater-like hollow, in which grow some very large canes. Shortly afterwards the strata of fresh water deposit were seen to be vertical, and were filled with a species of Gnathodon (G. Lecontei *Conrad*). About 4 P. M., we skirted along the northern edge of a long curved range of hills, the base of which was composed of strata of limestone dipping outwardly, and containing also Gnathodon; around these hills and mounds were concentric lines of small stones from the mountains arranged by aqueous action.

About half past five, we encamped in the bed of Cariso creek, here entirely dry; the night was stormy, but a melon apiece, and the warmth of a large mesquite fire soon made us contented. Leaving at four the next morning, we reached Vallecitas in the afternoon, without farther adventure, worthy of being here narrated.

NOTE.—By the kindness of Capt. Davidson, I learn that while he was stationed at Fort Yuma, in Dec., 1853, a violent earthquake occurred; the ground in the vicinity of the Fort opened, forming fissures, from which were thrown mud, sand and water: portions of the mountains several miles distant were seen to fall, and about forty miles S. E. of the Fort, in the direction of some springs, said to be similar to those herein described, was seen an immense column of steam. It is to be hoped that some of the officers then at the post will favor science with an account of the phenomena observed.

ART. II.—*On the Geographical Distribution of Crustacea*; by JAMES D. DANA.

(Continued from vol. xviii, p. 326.)

V. TETRADECAPODA.

BEFORE stating the conclusions from the tables* of the Tetradecapoda, it should be observed that this division of Crustacea has been less thoroughly explored than that of the Podophthalmia, and future investigations must vary much the proportions between the species of the different regions. The coasts of Europe and the northern seas, are within the reach of European zo-

* As already mentioned the Tables published in the original Report are here omitted.

ologists, and have been carefully examined; while voyagers through the tropics have usually contented themselves with collecting the larger Crustacea. In the genus Gammarus, not a tropical species had been reported, until our investigations, which brought ten or eleven to light, being one-third the whole number of those of ascertained localities reported to this genus.

Some general conclusions may, however, be safely drawn from the facts already known, although the exact ratios deduced from the tables may hereafter be much modified.

I. The Tetradecapoda are far more numerous in extra-tropical latitudes than in the tropical.

The proportion in the table is 521 : 146; allowing for future discoveries, it may be set down at 2 : 1, without fear of exceeding the truth.

II. The *genera* of extra-tropical seas are far more numerous than those of the tropical.

Out of the forty-nine genera of *Isopòda*, only nineteen are known to occur in the tropics, and but four of these are peculiar to the tropics.

Out of twenty genera of *Anisopoda*, six only are known to be tropical, and but two are exclusively so.

Among the *Amphipoda*, out of fifty genera of *Gammaridea*, only seventeen are known to contain tropical species; nine are exclusively tropical, and but ten, including these nine, have more tropical than extra-tropical species. The Caprellidea and Hyperidea embrace thirty genera, fifteen or sixteen of which include tropical species.

The variety of extra-tropical forms compared with the tropical, is hence very great.

III. From the tables, the ratio of extra-tropical and tropical species in the

Isopoda, is	4 : 1
Anisopoda, ...	6 : 1
Amphipoda, ...	3 : 1

Among the Isopoda, the Idotæidea are the most decidedly cold-water species, and the Cymothoidea, the least so. The ratio of species for the

Idotæidea, is	8 : 1
Oniscoidea, ...	7 : 1
Cymothoidea, ...	$2\frac{1}{8}$: 1

Two-ninths of the extra-tropical Idotæidea (or nine species) belong to the Frigid zone, and nearly one-tenth of the extra-tropical Oniscoidea (or nine species); while less than a twenty-fifth of the Cymothoidea occur in the Frigid zone, and but one of these has not also been found in lower latitudes.

Of the Amphipoda, the Gammaridea are most strongly extra-tropical, the proportion being for the extra-tropical and tropical species $3\frac{1}{2}:1$; while the ratio in the Caprellidea, is $3:1$; and in the Hyperidea, $1\frac{1}{4}:1$. Out of one hundred and seventy-eight extra-tropical species of Gammaridea, sixty-six are Frigid zone species, besides two which have been found both in the Frigid and Temperate zones.

IV. The genera which extend into the frigid region are the following. The names of those more especially frigid, according to present knowledge, are italicised; and the proportion of frigid species to the whole number of extra-tropical, is mentioned in decimals, where they are not exclusively frigid.

IDOTÆIDEA.—Idotæa (0·3), *Glyptonotus.*

ONISCOIDEA.—Jæra (0·25), *Jæridina*, Asellus (0·20), Janira (0·5), *Henopomus*, *Munna* (0·66).

CYMOTHOIDEA.—Æga (0·4).

SEROLIDEA.—Serolis (0·2), Praniza (0·15), Anceus (0·25).

ARCTURIDEA—Arcturus (0·5).

TANAIDEA.—Tanais (0·5), *Liriope, Crossurus, Phryxus, Dajus.*

CAPRELLIDEA.—Proto (0·5), Caprella (0·24), Ægina, *Cercops, Podalirius.*

GAMMARIDEA.—*Dulichia, Siphonœcetes,* Unciola (0·5), Podocerus, (0·5), *Laphystius,* Orchestia (0·07), *Stegocephalus,* Opis (0·66), *Uristes, Anonyx,* (0·9), Leucothoe (0·66), *Acanthonotus,* (0·75), *Iphimedia* (0·6), Œdicerus (0·5), Gammarus (0·33), Melita (0·5), *Pardalisca, Ischyrocerus, Michrocheles, Pontoporeia, Ampelisca, Protomedeia, Phoxus.*

HYPERIDEA.—Hyperia (0·14), *Metœcus, Tauria, Themisto,* (3·0).

The Spheromidæ are nearly all cold-water species, though not reaching into the Frigid zone. There are forty-nine known species of Spheromidæ in the Temperate zone, and but *four* in the Torrid. *Serolis* is a peculiar cold-water form, belonging mainly to the subfrigid and frigid regions. *Orchestia* is to a large extent of the Temperate zone, while *Allorchestes* is more equally distributed through the torrid and temperate. Amphithoe, as restricted by us, is alike common in the torrid and temperate regions; while Iphimedia, the other section of the old group, is mainly a cold-water genus.

The Hyperidea are mostly tropical genera.

V. The species and genera of Tetradecapoda are not only most abundant in the extra-tropical regions, but besides, the individuals of species appear to be more numerous, or at least not less so. At Fuegia, the quantity of Gammaridæ collected on bait dropped in the water was exceedingly large; and in no region visited by us, did we find evidence of as great profusion. The Spheromæ were also very abundant along the shores.

VI. Moreover, the species of extra-tropical waters are the largest of the tribe. In the Frigid zone, there are Idotæidæ three to four inches long, while the average size of the tropical species is less than three-fourths of an inch; there are Spheromæ an inch long, while those of the tropics seldom exceed a fourth of an inch; there is a Lysianassa three inches long, while the warmer seas afford only small species half an inch in length; there is a Pterelas over an inch in length, while the Ægidæ of the tropics are less than half an inch. The Gammari of the tropics are small slender species, not half the size of those of the colder seas. The species of Serolis are an inch to two inches long. Thus, through the Idotæidæ, the Ægidæ, Serolidæ, Spheromidæ, Caprellidea, and Gammaridea, the largest species belong to the colder seas, and the giants among Tetradecapods, are actually found in the Frigid zone.

Among the Hyperidea there is one gigantic species, belonging to the genus Cystisoma, which is over three inches long. It is reported from the Indian Ocean, but whether tropical or not, is unascertained. Of the species of this group examined by the writer, the largest, a Tauria, was from the Frigid zone.

VII. Again, the Tetradecapoda of extra-tropical waters are the highest in rank. Among the Isopoda (which stand first), the Idotæidea appear to be of superior grade, and these, as observed, are especially developed in the colder seas, reaching their maximum size in the Frigid zone. Again, the Serolidæ, the highest of the Anisopoda, are cold-water species. The Orchestiæ among the Amphipoda, although reaching through both the Torrid and Temperate zones, are largest and much the most numerous in the latter.

VIII. Those species of a genus that occur in the colder waters, are often more firmly put together, and bear marks of superiority in their habits. The Amphithoe and Gammari of the tropics are lax and slender species, of small size compared with those of the colder seas.

IX. There is a tendency in the colder waters to the development of spinous species. This fact is as true of the Podophthalmia as of the Tetradecapoda. Among the former, there are the thorny *Lithodes*, the numerous *Maioids* armed with spines, the *Acanthodes;* while the Cancroids and Grapsoids of the tropics are usually very smooth and often polished species. There are the spinous boreal Crangons, the species of which genus in the warmer seas are without spines. Among the Tetradecapods, the *boreal* Iphimediæ are often spinous or crested; Acanthonotus and Dulichia are spinous genera. The same tendency is seen in the third pair of caudal stylets in some cold-water Gammari, which have the branches spinulous instead of furnished with a few minute hairs like those of the tropics.

There are also some spinous Crustacea in the tropics, as the Palinuridæ and species of Stenopus. Such facts, however, do not lead to any modification of the previous remark; for the tendency observed is still a fact as regards the several genera mentioned; moreover the spinous tropical species are few in number.

VI. ENTOMOSTRACA.

The Entomostraca have been little studied out of the Temperate zone, if we except the results of the author's labors. The described species of most of the families are, therefore, almost exclusively from the temperate regions, and we know little of the corresponding species or groups in the warmer seas. The following table presents the number of known species of the torrid and extra-torrid zones, omitting the Lernæoids:—

TABLE IV.

	Torrid zone.	Extra-torrid zone.
LOPHYROPODA.		
Cyclopoidea,	120	76
Daphnioidea,	5	46
Cyproidea,	13	61
PHYLLOPODA.		
Artemioidea,	0	10
Apodoidea,	0	3
Limnadioidea,	2	2
PŒCILOPODA.		
Ergasiloidea,	1	4
Caligoidea,	16	33

Were we to leave out of view the researches of the author, the number of species and the proportion for the Cyclopoidea, instead of 120 to 76, would be about 3 : 50, thus not only reversing the ratio, but giving to the Temperate zone almost all the species of the group.* Moreover, no Daphnioids and few Caligoids have been yet reported from the Torrid zone, excepting those described in this Report. The author's time when on land in the tropics was devoted mainly to the department of Geology, and consequently the fresh-water Entomostracans were not as thoroughly collected as those of the oceans. He therefore attempts to draw no conclusions from the above ratios.

A few facts may, however, be deduced with respect to some genera, and especially those of the Cyclopoidea. The following table gives the number, as nearly as known, of the species of each genus of the Cyclopoidea, occurring in the torrid and extra-torrid zones. The number common to the extra-torrid and torrid zones is mentioned in brackets.

* The whole number of Cyclopoidea described previous to May, 1842, by which time the author's observations were completed, was less than *twenty-five;* and of the oceanic Cyclopoids, one hundred and fifty species of which the author has described, not *ten* were then known. We may judge from these results of a single cruise what still remains to be done in the department of Entomostraca.

TABLE V.

CYCLOPOIDEA.

	Torrid.	Extra-torrid.
I. CALANIDÆ.		
1. *Calaninæ.*		
Calanus, . .	25	12 (3)
Rhincalanus, .	2	
Cetochilus, .		1
Euchæta. . .	4	1
Undina. . .	3	
2. *Oithoninæ.*		
Oithona, . .	2	1
3. *Pontellinæ.*		
Diaptomus, .		2
Hemicalanus, .	4	
Candace, . .	5	1
Acartia, . .	3	1
Pontella, . .	22	9 (3)
Catopia, . .	1	
4. *Notodelphinæ,*		
Notodelphys, .		1
II. CYCLOPIDÆ.		
1. *Cyclopinæ.*		
Cyclops, . .	2	9
? Psammathe, .		1
? Idomene, .		1
? Euryta, . .		1
2. *Harpacticinæ,* .		
Canthocamptus,	2	4
Harpacticus, .		15
Westwoodia, .		1
Alteutha, . .		1
Metis, . . .		1
Clytemnestra, .	1	
Setella, . . .	5	1 (1)
Laophon, . .		1
Oncæa, . . .		1
Ænippe, . .		1
Idya, . . .		1
3. *Steropinæ.*		
Zaus, . . .		1
Sterope, . .		4
III. CORYCÆIDÆ.		
1. *Corycæinæ,*		
Corycæus, .	18	1
Antaria, . .	3	1 (1)
Copilia, . .	2	
Sapphirina, .	15	5
2. *Miracinæ.*		
Miracia, . .		1
Total CALANIDÆ, . .	71	29 (6)
Total CYCLOPIDÆ, . .	10	44 (1)
Total CORYCÆIDÆ, .	39	8 (1)

The properly oceanic genera include all the *Calanidæ*, excepting *Diaptomus* and *Notodelphys;* all the *Corycæidæ;* with only the single genus *Setella* among the Cyclopidæ.

Among the Calanidæ, the genera are mainly tropical, yet each affords some extra-tropical species; and those which are most abundant in the colder waters are Calani or closely allied. *Setella* occurs beyond the tropics; but all the species thus far examined are found in the Torrid zone. *Pontella* is more of a warm-water genus than Calanus. The Corycæidæ are to a large extent tropical; the genus *Corycæus* is almost exclusively so, while *Sapphirina* is common in the Temperate zone. The Steropinæ are Frigid species.

Although the Calanidæ are more varied in species within the tropics, they abound more in individuals in the colder seas. Vast areas of "bloody" waters were observed by us off the coast of Chili, south of Valparaiso (latitude 42° south, longitude 78° 45′ west, and latitude 36° south, longitude 74° west), which were mainly due to a species of this group; and another species was equally abundant in the North Pacific, 32° north, 173 west.* They have been reported as swarming in other seas, constituting

* The species in the former case was the *Pontella* (subgen. *Calanopia*) *brachiata;* and in the latter, *Calanus sanguineus.*

the food in part of certain species of whale. Such immense shoals we did not meet with, within the tropics.

Among the *Daphnioidea*, the genera Daphnella, Penilia, Ceriodaphnia, and Lynceus were observed by us in the Torrid zone. Of the *Cyproids*, Cypridinia, Conchœcia, and Halocypris are oceanic forms, and mainly of the tropical oceans.

The *Caligoids* spread over both zones. Caligus and Lepeophtheirus reach from the equator to the frigid seas; Nogagus, Pandarus, and Dinematura are represented in both the Torrid and Temperate zones.

GENERAL REMARKS AND RECAPITULATION.

We continue by presenting a few general deductions from the tables, and a recapitulation of some principles.

A survey of all the great divisions of Crustacea, shows us that exclusive of the Entomostraca, they are distributed, according to present knowledge, as follows:

	a. Torrid zone.	*b.* Temperate zone.	*c.* Frigid zone.
Brachyura,	535	257 (34 *a*)	2 (5 *b*)
Anomoura,	125	110 (15 *a*)	4 (1 *b*)
Macroura,	148	125 (16 *a*)	29 (2 *b*)
Anomobranchiata,	82	33 (9 *a*)	2
Isopoda,	56	208 (1 *a*)	21 (3 *b*)
Anisopoda,	8	34	15
Amphipoda,	82	157	83 (4 *b*)
Total,	1036	924 (75 *a*)	159 (14 *b*)

Taking the sum of the Frigid and Temperate zone species (subtracting the fourteen common to the two) we have 1036 species in the torrid regions to 1069 in the extra-torrid, seventy-five of which are common to the two. This shows a nearly equal distribution between the zones. But excluding the Brachyura, the numbers become 501 to 811, giving a preponderance of more than one-half to the Temperate zone.*

* Adding to the numbers above, the species which have been necessarily left out as of uncertain locality, amounting to one hundred and forty in all, and inserting also the Entomostraca, it makes the total of described living species in 1853, as follows:—

Brachyura,	830	
Anomoura,	262	
Macroura,	297	
		1389
Anomobranchiata, (Mysidea, Squilloidea, Amphionidea,)		115
Isopoda,	295	
Anisopoda,	57	
Amphipoda,	341	
		693
Entomostraca,		492
Total,		2689

The number of species collected in the cruise of the Expedition (exclusive of those lost in the wreck of the Peacock, which included nearly all the collections of

The species of highest rank among the Brachyura, Macroura, Isopoda, and Amphipoda, the four principal types in the above, belong to the extra-torrid zones; and in subordinate groups or families, it is often true that the genera of superior grade are extra-torrid, in contrast with the others which are torrid genera. Higher groups, characteristic of the colder regions, sometimes show degradation among those species of the group that are tropical; and the tropical sections also may continue the line of degradation by an extension again into the colder seas.

As we descend in the scale of Crustacea from the Podophthalmia to the Tetradecapoda, the number of cold-water species increases, becoming in the latter group, three times greater than the warm-water species. It is an important fact, nevertheless, that this increase of cold-water species is still no mark of degradation; the particular facts that have been discussed, leading to a very different conclusion. Other principles follow. These are—

First, that the two types, the Decapodan and Tetradecapodan, are distinct types, to be independently considered, and not parts of a series or chain of species—a fact illustrated in the chapter on the Classification of Crustacea.

Second, that the preponderance of cold-water species is the reverse of what must have been true in the earlier geological epochs, when the oceans had a somewhat higher temperature; or were to a large extent tropical.

Third, that the progress of creation as regards Crustacea, has ended not where it begun, in multiplying the species of warmer waters and giving them there their superior developments, but in carrying species to a higher perfection in the colder regions of the oceans. A preponderance of species in the warmer seas is perhaps to be expected, since warm waters have prevailed even more largely than now in earlier epochs. But it would seem, that the introduction of the higher grades of Crustacea required, not merely the cooler waters of the present tropics, but even the still colder temperature of the Temperate zone, and therefore the present condition of the globe.

two seasons in the tropical regions of the Pacific) is nearly 900; and the number of new species described is 658, distributed among the groups as follows:

Brachyura,	151	
Anomoura,	50	
Macroura,	57	
Anomobranchiata,	28	
		286
Isopoda,	67	
Anisopoda,	7	
Amphipoda,	110	
		184
Entomostraca,		188
Total,		658

The genera of Fossil species commence with the Entomostracans and Trilobites in the Palæozoic rocks. Next appear certain *Thalassinidea* and *Astacoid* species, in the Permian system; then *Mysidea*, *Penæidea*, many *Thalassinidea*, *Astacoidea*, and *Anomoura*, in the Oolitic system; then a few *Cancroids* and *Leucosoids* in the Cretaceous, which become much more numerous in the *Tertiary* system, along with some *Grapsoids*. None of the *Maioids*, the highest of Crustacea, have yet been reported from either of the Geological epochs.

The *number* of individuals and the *size* are, for the Brachyura, greater in the Torrid zone than in the colder regions. But for the Macroura, the species of cold-water genera average nearly twice the lineal dimensions of those of warm waters; and the number of individuals also may possibly be greater.

In stating the conclusion respecting the Macroura, on a preceding page (last volume, p. 325), we omitted to give in detail the mean sizes of the different groups. The following are the results, including the Galatheidea which are closely related to the Macroura:—

	Mean length of Torrid zone species.	Mean length of Extra-torrid species.
Galatheidea,	0·3 inches.	3·0 inches.
Thalassinidea,	2·0 "	3·0 "
Scyllaridæ,	6·0 "	6·0 "
Palinuridæ,	12·0 "	15·0 "
Astacidæ.—Homarus,		14·0 "
Astacinæ,		3·0 "
Nephrophinæ,		5·0 "
Crangonidæ,		2·0 "
Palæmonidæ.—Alpheinæ,	1·5 "	1·5 "
Pandalinæ,		3·0 "
Palæmoninæ,	2·3 "	2·4 "
Oplophorinæ,	1·0 "	
Penæidæ,	3·6 "	4·5 "

The table shows that the torrid species, in none of the groups, average larger than the extra-torrid. The cold-water Palinuridæ are as large as the largest warm-water species, and will outweigh them; the cold-water Galatheidea, are ten times the average length of the warm-water; the Alpheinæ, Palæmoninæ, and Penæidæ are at least as large in the temperate regions as in the torrrd. There is hence nothing in the tropics to balance the Astacidæ, a group of large species, some of them gigantic; nor the Crangonidæ, nor Pandalinæ. The genus Palæmon, in the Torrid zone, averages larger than in the Temperate, the ratio being 3·5 to 2·4; the former amount being reduced to 2·3 for the Palæmoninæ, by the species of the other tropical genera, which are mostly quite small. Yet, taking the ratio of 3·5 to 2·4, it affects but little the balance against the Torrid zone.

As to *bulk*, also, the Temperate zone probably has the preponderance; yet our data are less definite. In the Galatheidea, the cold-water species are not only ten times larger lineally (which implies at least eight hundred times cubically), but they are far more prolific, swarming in vast numbers where they occur. The Thalassinidea are more numerous in extra-torrid species than torrid, as well as larger in size. The Scyllaridæ are mainly tropical; but the species are not of common occurrence, compared with the Astacidæ, which abound everywhere, and these, as well as the Crangonidæ and Pandalinæ, are all Temperate zone species. The Palæmoninæ and Penæidæ probably preponderate in the tropics, and this may be also true of the Alpheinæ. Taking a general view of the whole, and considering the fact, that the extra-torrid species rather outnumber the torrid, we believe that the deduction above stated is correct.

In the *Tetradecapoda*, the number of species, the number and diversity of genera, the number of individuals, and the bulk, are all greater in the extra-torrid seas than in the torrid, as has been explained on a preceding page; and this is especially true of the Amphipoda.

The tendency to spinose forms among the species of the colder temperate regions, or Frigid zone, has been remarked upon on page 9, as exemplified among the Gammaridea, the Crangonidæ, Lithodes, and Maioids.

(*To be continued.*)

Art. III.—*Contributions to Mineralogy;* by Dr. F. A. Genth of Philadelphia.

(Continued from vol. xviii, p. 410.)

5. *Tetradymite.*

After making the examination of the Tetradymite from Davidson county, N. C. (Am. Journ., 2d Ser., vol. xvii, page 81), I was very desirous to reëxamine the mineral, which had been analyzed by Mr. Coleman Fisher, Jr., (Am. Jour., 2d Ser., vol. vii, p. 282). Fortunately Prof. R. S. McCulloh (who was at the time of its discovery at Commodore Stockton's mines in Virginia, Melter and Refiner at the U. S. Mint) had preserved some of the same material, which was analyzed by Mr. Fisher, and he very kindly gave me *all* that he had for examination. This was sufficient for the whole investigation. The pieces were of two different kinds, viz: Tetradymite associated with quartz and gold, and Tetradymite in broad folia, sometimes one inch in diameter, implanted in a decomposed micaceous slate. The latter mineral undoubtedly came from the Tellurium Mine, Fluvanna county, Va. and is that analyzed by Mr. Fisher; the former is probably from the same place, but may be from Whitehall Mine, Spotsylvania county, Va.

Though I was most careful in selecting the material for this investigation, I found invariably from one half to two per cent. of quartz, gold and oxyd of iron mixed with it, which were deducted as impurites.

In making the investigation I have found the method heretofore used for the separation of bismuth from tellurium, by sulphid of ammonium, not to be as correct as is desirable, since there is always a considerable amount of tellurium remaining with the bismuth ; I therefore tried to find another mode, which would give more satisfactory results, and succeeded best with the following: The solution containing teroxyd of bismuth and tellurous acid was made acid by hydrochloric acid, and to the hot solution bisulphite of ammonia was added. It was allowed to stand in a warm place for a day or two until all the tellurium had settled ; this was filtered on a weighed filter, washed first with a mixture of diluted hydrochloric and sulphurous acids, then with sulphurous acid alone, and finally with water. The tellurium was completely precipitated and did not contain a weighable quantity of bismuth. The results of the analyses I. and II. were afterwards corrected, and III. and IV. analyzed by this method. B.B. it fuses readily giving out a faint but distinct odor of selenium, leaving on charcoal white incrustations with a yellow centre. The following results were obtained:

	I.	II.	III.	IV.	Calculated.
	From Tellurium Mine.			? From Whitehall Mine.	
Bismuth,	53·07	53·78	51·56	Not determ.	1 equiv. Bi=51·94
Tellurium,	48·19	47·07	49·79	46·10	3 " Te=48·06
Selenium,		*traces*			
Sulphur,	none	none	none	0·37	

These analyses show that neither of the specimens contained a weighable amount of selenium. The small quantity of sulphur (in No. IV,) 0·37 per ct. is equivalent to 1·48 per ct. of tellurium, which if we substitute tellurium for sulphur, would give 47·53 per ct. of tellurium. These analyses show that Tetradymite is tertellurid of bismuth, but that sometimes (as I showed for that from Davidson county) a variable quantity of tellurium may be replaced by sulphur. I have also observed that Tetradymite occurs at several localities in Cabarrus county, N. C., where I have found it in minute lead-colored scales, associated with gold and iron pyrites in quartz at the Phœnix Mine and at the Boger Mine ; but, though I had sufficient material to determine the nature of the scales, I could not obtain enough for a quantitative analysis.

6. *Bismuthine.*

On examining some ores from Gold Hill, Rowan county, N. C., I found that the crevices in specimens from the Barnhardt vein (from 280 feet below the surface) sometimes contained a steel colored mineral in minute acicular needles, which are apparently rhombic. It was associated with gold, iron and copper pyrites. B.B. it gave the reactions of sulphur, bismuth and copper, and once I observed a faint odor of selenium. Afterwards I found that the chloritic slate of the same vein, in which the copper pyrites occurs, contains also a considerable quantity of almost microscopic specks and stripes of the same color. On extracting some of the slate by aqua regia, the solution contained, besides iron and copper (probably from the copper pyrites), a considerable quantity of bismuth. Neither tellurium nor lead could be found. It is impossible to get a sufficient quantity of this mineral for analysis, or of sufficient purity to ascertain whether the copper, which I found, belongs to the mineral itself, or is owing to an admixture of copper pyrites—or, in other words, whether the mineral is "*Cupreous Bismuth*," or *Bismuthine*. I am in favor of the latter opinion.

7. *Aciculite.*

A mineral between lead and steel-gray in color occurs in small masses imbedded in quartz and associated with copper pyrites and sulphate of baryta. Though it is not found in long acicular needles, like the needle ore from Beresofsk in Siberia, a qualitative analysis showed that it contains the same constituents, viz: bismuth, lead, copper and sulphur.

B.B. it fuses readily, giving off sulphurous acid and covering the charcoal with yellow incrustations; with carbonate of soda, after the lead and bismuth have been volatilized, a globule of copper remains.

I therefore believe it to be "*Aciculite.*"

8. *Barnhardtite, a new mineral.*

a. In compact masses; no cleavage could be observed. H. = 3·5; Sp. grav. (at 25° Cels.) = 4·521; lustre metallic, but somewhat dull; color bronze-yellow; streak grayish black and slightly shining; opaque; fracture conchoidal, uneven; brittle; tarnishes very soon, more readily in presence of moisture, assuming a peculiar brownish, sometimes pinchbeck-brown, sometimes also rose-red and purple colors.

B.B. gives off sulphurous acid and fuses easily to an iron-black magnetic globule; with borax it gives the reactions of copper and iron; with carbonate of soda and borax metallic copper. It was analyzed in my laboratory by Mr. Wm. J. Taylor (I), Mr. Peter Keyser (III) and myself (II), and a copper determination was made by Mr. Chs. A. Kurlbaum (IV).*

* In analyses I. and II. a trace of brown hematite was mixed with the mineral; and in analysis II. some copper was lost.

The following are the results:

	I.	II.	III.	IV.	Calculated.
	From D. Barnhardt's land.	From Pioneer Mills.			
Copper,	47·61	46·69	48·40	47·86	4 equiv. Cu = 48·14
Iron,	22·23	22·41	21·08	not det.	2 " Fe = 21·33
Sulphur,	29·40	29·76	30·50	not det.	5 " S = 30·53
Silver,	*trace*				

The composition is expressed by the formula: $2Cu_2S+Fe_2S_3$, which is between that of yellow copper pyrites$=Cu_2S+Fe_2S_3$ and Erubescite $=3Cu_2S+Fe_2S_3$.

I have found this mineral associated with other copper ores at Dan. Barnhardt's land (hence its name) and Pioneer Mills, Cabarrus county; Dr. O. Dieffenbach observed it at the Phœnix and Vanderburg Mines of the same county, and I saw it also amongst copper ores from the neighborhood of Charlotte, Mecklenburg county, N. C. It seems to be abundant in North Carolina, and is of course a very valuable copper ore.

b. I will mention here another copper ore, which also occurs on Dan. Barnhardt's farm.

It is massive and resembles copper pyrites, but is somewhat paler. The material for analysis was uniform in appearance and seemed not to be a mixture of two species.

The analyses made by Messrs. Wm. J. Taylor (I) and Charles Froebel (II), gave the following results:

	I.	II.	Calculated.
Copper,	40·2	40·5	5 equiv. Copper = 39·67
Iron,	28·4	28·3	4 " Iron = 28·12
Sulphur,	32·9	31·1	8 " Sulphur = 32·21

The composition of this mineral may be expressed by the formula: $(2Cu_2S+Fe_2S_3)+(Cu\,S, +2Fe\,S.)$

Whether further investigations will prove this to be a distinct species or not, I am not able to say; for the present I only wish to call the attention of mineralogists to this subject.

9. *Gray Copper*, (*Fahlerz.*)

In the Am. Journ. of Sc., 2d Ser., vol. xvi, page 83, I have described the first mineral belonging to this group, which has been observed in this country. Since then I have found two new localities, where minerals occur belonging to this group, and a third one (Duchess county, N. Y.) was mentioned to me by Dr. Isaiah Deck.

a. From Eldridge's Gold Mine, Buckingham county, Va.—In granular masses; lustre metallic; color between iron-black and lead-gray; streak iron-black; opaque; H.=4. Very brittle; fracture uneven—subconchoidal.

B.B. in an open tube disengages sulphurous acid; and gives a sublimate of arsenious acid. On charcoal it emits fumes of an alliaceous odor, and fuses with intumescence to an iron black, slightly magnetic globule, covering the charcoal with white incrustations. With fluxes it gives the reactions of copper and iron.

A preliminary analysis, made by dissolving the mineral in aqua regia, gave Mr. Wm. J. Taylor the following results:

Copper,	40·64 pr. cent.
Silver,	0·42
Gold,	*trace*
Zinc,	3·39
Iron,	4·24
Antimony,	5·10
Arsenic,	16·99
Sulphur,	28·46
Quartz,	1·24

It is associated with quartz and auriferous iron pyrites.

b. From Geo. Luderick's farm, about 14 miles N. E. of Concord, Cabarrus county, N. C.—The only imperfect crystal which I found appears to be a combination of $\frac{O}{2} \cdot \frac{2O2}{2} \cdot \infty O$; it is generally found massive; its color is between dark lead gray and iron black; streak iron black, somewhat brownish; fracture uneven, subconchoidal; brittle.

B.B. decrepitates slightly; in an open tube disengages sulphurous acid and gives a sublimate of arsenious acid; on charcoal it emits fumes of an alliaceous order, and covers it with white incrustations; it fuses into a magnetic globule and gives with fluxes the reactions of copper and iron. It is found in quartz, associated with copper pyrites, iron pyrites, brown hematite and scorodite.

10. *Geokronite.* (?)

I received this mineral amongst others from Tinder's Gold Mine, Louisa county, Va.

It occurs in small irregular masses of a crystalline structure, with distinct cleavage in one direction; lustre metallic; color lead gray; opaque; H.=3; Sp. grav. (at 16° Cels.) 6·393.

B.B. upon charcoal gives off sulphurous acid and copious fumes of teroxyd of antimony, covering it with white incrustations, having a yellow centre of oxyd of lead; further reduced yields a small globule of silver; in an open tube it gives off sulphurous acid and a white sublimate of teroxyd of antimony and arsenious acid.

A rough experiment showed that it contains about 16 per cent. of sulphur, 60 per cent. of lead, and 0·25 per cent. of silver.

Associated with iron pyrites, galena and blende.

11. *Garnet.*

a. From Yonkers, N. Y.—This beautiful massive red garnet, which I have found in many collections labelled "Pyrope," has been examined in my laboratory, by Mr. Wm. J. Taylor.

B.B. it fuses to an iron black, slightly magnetic globule; with borax it gives the reactions of iron, and with carbonate of soda those of manganese. It is acted upon by hydrochloric acid, but not completely decomposed. The analysis gave the following results.

Silica,	38·32 per cent. contains Oxygen	19·90		=	2
Alumina,	21·49 " "	10·05		=	1
Oxyd of iron (FeO)	30·23 " "	6·71	10·16	=	1
Oxyd of manganese,	2·46 " "	0·55			
Magnesia,	6·29 " "	2·51			
Lime,	1·38 " "	0·39			

b. From Greene's Creek, Delaware county, Pa.—Under the head "Pyrope," Prof. Dana mentions this beautiful gem, stating his doubts, that it belongs to this species. The following analysis, made by Mr. Chs. A. Kurlbaum will, show the correctness of his view.

B.B. it behaves like *a*; its composition is:

Silica,	40·15 per cent. contains Oxygen,	20·86		=	2
Alumina,	20·77 " "	9·71		=	1
Oxyd of iron (FeO)	26·66 " "	5·92	10·09	=	1
Oxyd of Manganese,	1·85 " "	0·42			
Magnesia,	8·08 " "	3·23			
Lime,	1·83 " "	0·52			

12. *Allanite.*

Though we have already numerous analyses of this mineral, we are not yet arrived to a certainty with regard to its composition. This is owing to various causes, principally, I suppose, to the fact that analysts have in most cases not taken the necessary care to ascertain, whether the iron in allanites is in the form of oxyd (FeO) or in that of sesquioxyd (F_2O_3), or in both states of oxydation. At my request, Mr. Peter Keyser made a series of analyses of American allanites. The separation of the oxyds of cerium, lanthanum and didymium from iron and alumina in all the analyses (α) was made by sulphate of potash; in analyses (β) by oxalic acid; sesquioxyd of cerium was separated from lanthana and oxyd of didymium by very diluted nitric acid and the oxyd of iron by chlorid of gold and sodium. All the rest of the determinations were made in the usual manner.

a. Allanite from Orange county, N. Y.*—Massive, no cleavage could be detected; H. 5·5; Sp. gr. (at 17° Cels.) = 3·782; lustre

* This is the mineral of which I spoke in my note in the Am. Journ. of Sc., 2d Ser., vol. xvi, page 86.

resinous; streak gray; color pitch-black: opaque; fracture uneven—subconchoidal; brittle.

B.B. it fuses with intumescence to a black slightly magnetic glass. Dissolves easily in hydrochloric acid.

The analyses gave the following results.

	α		β	Mean.	Contains oxygen.	
Silica,	32·22		32·17	32·19	16·71	=16·71
Alumina,	11·99		12·00	12·00	5·61	= 7·51
Sesquioxyd of iron,	6·30		6·39	6·34	1·90	
Oxyd of iron,		10·55		10·55	2·34	= 9·18
Oxyd of manganese,	0·51		not det.	0·51	0·11	
Oxyd of cerium,	15·28		15·45	15·37	2·22	
Lanthana, Oxyd of didymium,	8·79		8·89	8·84	1·29	
Magnesia,	0·54		1·14	0·84	0·34	
Lime,	8·98		9·31	9·14	2·60	
Soda,		1·00		1·00	0·25	
Potash,		0·18		0·18	0·03	
Water,		1·19		1·19	1·06	= 1·06

b. Allanite from near Eckhardt's Furnace, Berks county, Pa.—In color, general appearance and its blowpipe reactions, resembles very much the allanite from Orange county.

H. = 6; Sp. gr. (at 27° Cels.) = 3·825–3·831.

The analyses gave the following results:

	α		β	Mean.	Contains oxygen.	
Silica,	32·97		32·81	32·89	17·07	= 17·07
Alumina,	12·40		12·59	12·49	5·84	= 8·04
Sesquioxyd of iron,	7·10		7·56	7·33	2·20	
Oxyd of iron,		9·02		9·02	2·00	= 8·46
Oxyd of manganese,	0·25		not det.	0·25	0·05	
Oxyd of cerium,	15·79		15·56	15·68	2·27	
Lanthana, Oxyd of didymium,	10·17		10·02	10·10	1·47	
Magnesia,	1·91		1·63	1·77	0·61	
Lime,	7·30		6·94	7·12	2·02	
Soda,		0·09		0·09	0·02	
Potash,		0·14		0·14	0·02	
Water,		2·49		2·49	2·21	= 2·21

It is found abundantly near Eckhardt's Furnace, Berks County, Pa., associated with quartz, zircon, mica and titaniferous magnetite.

c. Allanite from Bethlehem, Northampton county, Pa.—Massive; H. = 5; Sp. grav. (at 16° Cels.) = 3·491; lustre resinous; color brownish black; streak gray; opaque; fracture subconchoidal.

B.B. it decrepitates slightly and fuses with intumescence to an iron black magnetic slag. Hydrochloric acid dissolves it readily.

Occurs in a decomposed granite in flat pieces of not more than half an inch in thickness; their surfaces are covered with a crust of hydrated sesquioxyds of iron and cerium, etc., resulting from the decomposition of the allanite by the action of atmospheric water.

The results of the analyses were:

	α		β	Mean.	Contains oxygen.	
Silica,	33·36		33·27	33·31	17·30	= 17·30
Alumina,	14·54		14·13	14·34	6·70	= 9·95
Sesquioxyd of iron,	10·71		10·95	10·83	3·25	
Oxyd of iron,		7·20		7·20	1·60	= 8·15
Oxyd of cerium	13.72		13·11	13·42	1·94	
Lanthana, Oxyd of didymium,	2·76		2·64	2·70	0·39	
Magnesia,	0·95		1·52	1·23	0·68	
Lime,	11·27		11·28	11·28	3·21	
Soda,		0·41		0·41	0·11	
Potash,		1·33		1·33	1·22	
Water,		3·01		3·01	2·68	= 2·68

In the allanite from Orange county, the ratio of oxygen of $RO : R_2O_3 : SiO_3$, is equal to 1 : 0·8 : 1·8, which is = 5 : 4 : 9, corresponding with the formula: $5\dot{R}_3\dddot{Si}+4\dddot{\bar{R}}\dddot{Si}$, the allanites of Reading and Bethlehem give very near the ratio 1 : 1 : 2, corresponding with the formula $\dot{R}_3\dddot{Si}+\dddot{\bar{R}}\dddot{Si}$.

The slight variation in the Orange county allanites of which the ratio of oxygen was found to be = 5 : 4 : 9 may be owing to small impurities of this mineral; I believe that, when pure, it has, like the two others, and like all allanites which have been examined with regard to the state of oxydation of the iron in them, the ratio 1 : 1 : 2, or the constitution of garnet. The quality of water in the allanites, resulting in all probability from a change, beginning in the composition of this mineral, as previously suggested by Prof. Rammelsberg, was found to vary from 1·19 per cent. to 3·01 per cent.; but if we take it into consideration, the composition of the Orange county allanite may be expressed by the formula $2(\dot{R}_3\dddot{Si}+\dddot{\bar{R}}\dddot{Si})+\dot{H}$; that of the allanites from Bethlehem and Eckhardt's Furnace by $(\dot{R}_3\dddot{Si}+\dddot{\bar{R}}\dddot{Si})+\dot{H}$.

13. *Tungstates* in North Carolina.

Tungstates having been found only at two or three localities in the United States, it was interesting to find them in North Carolina at two localities, viz: Dr. Cosby's mine, near Pioneer Mills, Cabarrus county, (*a*, *b* and *c*,) and at the Washington mine, Davidson county, (*d*).

a. Wolfram occurs in irregular lamellar masses in brown hematite and in a hydrate of the sesquioxyds of iron and manganese, which appears to be a result of the decomposition of spathic iron. It is associated with scheelite, tungstate of copper, and sulphate of baryta.

b. Scheelite is found in white, yellowish white and brownish crystals and crystalline masses. The crystals are rough and very imperfect, but on one I could observe the planes P . 0P . P ∞. They are sometimes more than half an inch in length. It occurs also in granular and compact masses.

c. Tungstate of Copper (? and Lime); a new mineral.—? Amorphous; massive and pulverulent; sometimes (if massive) of the lustre of wax, but usually dull; color between siskin and pistachio-green.

B.B. in a tube gives water and blackens; on charcoal it fuses with intumescence easily to an iron-black slag, containing globules of metallic copper; with fluxes it gives the reactions of copper and tungstic acid. Soluble in hydrochloric acid with separation of tungstic acid; the solution contains oxyd of copper and lime. I believe that the lime belongs to the constitution of this mineral, and is not owing to an admixture of Scheelite, with which it is associated, and that its composition is analogous to that of Volborthite, which it somewhat resembles, or a hydrated tungstate of copper and lime.

d. Scheeletine.—Only one lump of quartz, which had a few crystals of this very rare mineral upon it, was found at the Washington Mine, Davidson county, N. C.

The crystals are quadratic octahedra P, some also in combination with the plane ∞P. The planes sometimes being curved, give the crystals a barley shaped appearance. Color lavender blue and yellowish white; lustre pearly—subadamantine; brittle.

B.B. with microcosmic salt in the reducing flame gives an azure-blue glass; with carbonate of soda upon charcoal metallic lead. It is associated with pyromorphite, brown blende, iron pyrites, etc.

14. *Scorodite.*

I am not aware that another locality has been observed in the U. S., except Edenville, N. Y. It occurs also, coating the cavities of quartz and brown hematite, associated with gray copper, copper and iron pyrites at Geo. Luderick's farm, Cabarrus county, N. C.

It is found there in aggregations of greenish white, brownish and leek-green crystals. Only rarely they are large enough to distinguish their form, which is a combination of the planes $P . \infty \breve{P}2 . \infty \bar{P} \infty$.

15. *Wavellite.*

This is another mineral of which only a few localities are recorded in the United States. I found it at the Washington Mine, Davidson county, N. C., in a talcose slate in globular concretions with a radiated structure, associated with actinolite, galena, blende, iron pyrites, silver, etc.

Correction.—In the article, Owenite identical with Thuringite, this Journal, last volume, p. 411, for Schmiedeberg read Schmiedefeld.

Philadelphia, Oct. 4, 1854.

ART. IV.—*On the Diamagnetic Force;* by Prof. TYNDALL.*

WITH regard to the character of diamagnetic force great diversity of opinion prevails. In Germany we have Weber affirming that diamagnetic bodies possess a polarity opposed to that of iron. Weber's countryman, Von Feilitsch, combats this opinion in a series of Memoirs recently published in Poggendorff's '*Annalen.*' He affirms that diamagnetic bodies possess a polarity the same as that of iron; and endeavors to bring the phenomena into harmony with this view. In this country, on the contrary, we have Prof. Faraday, and it was believed, Prof. Thomson, neither of whom are prepared to admit the existence of any polarity whatever on the part of diamagnetic bodies. These divergences were a sufficient proof of the difficulty of the subject, and the necessity of caution in dealing with it; the author, therefore, thought it well to commence with the fundamental phenomena, and ascending from them to the more complicated, to endeavor to obtain, by strict adherence to experiment, a clear insight as to the real nature of that force by which certain bodies are repelled by the poles of a magnet.

From an extensive series of experiments made with different bodies, and under the most diverse circumstances, the author selected a few which clearly exhibited the law according to which the repulsive force augments when the strength of the repelling magnet is increased. Were the repulsion of a diamagnetic body dependent on any constant property of the mass, then its repulsion must be simply proportional to the strength of the magnet; but it is proved by the concurrent testimony of experiments carried on in Germany, France, and England, that, for a wide range of magnetic power, the repulsive force increases as the square of the strength of the influencing magnet. This leads inevitably to the conclusion, that the repulsion of a diamagnetic body depends, not alone on the magnet operating upon it, but upon the joint action of the magnet and diamagnet. A piece of bismuth, for example, in presence of the magnet is thrown by the latter into a state of excitement, which varies as the magnetic strength varies, and in virtue of which the substance is repelled. The next question to be decided is, whether the state of excitement evoked by one pole, in a diamagnetic body, enables a pole of an opposite quality to repel it.

To decide this, two cores of soft iron were so bent, that the two semi-cylindrical ends of the cores could be placed close together, so as to form a single cylinder of the same diameter as that of the straight portions of the cores. The cores being placed in suitable helices could be so excited that the contiguous poles

* Proceedings of the British Association, 1854, Athenæum, Oct. 7.

were of the same or of opposite names. A bar of bismuth was freely suspended, so that both poles could act upon it simultaneously. When the cores were excited, so that the poles were alike, the bismuth was repelled; when the poles were of different names, the bismuth bar remained motionless; all action upon it was annulled. This experiment confirms those of Reich, and proves that the condition, whatever it may be, which is evoked by one magnetic pole is neutralized by the other,—that each particular pole evokes a condition peculiar to itself;—and here we obtain the first glimpse of the dual nature of the force under consideration.

The next portion of the inquiry treated of the deportment of diamagnetic bodies when acted upon, first, by the magnet alone; secondly, by the electric current alone; and, thirdly, by the current and the magnet combined. When we speak of the deportment of bismuth in any one of the cases mentioned, no exact meaning can be attached to the phrase unless it be first strictly defined in what direction, as to the planes of crystallization, the mass has been cut. A bar of bismuth, in which the planes of principal cleavage are parallel to the length of the bar, and acted upon by the voltaic current alone, will set itself parallel to the current's direction. A bar, on the contrary, in which the planes of cleavage are transverse, will set itself at right angles to the current's direction, The former bar Prof. Tyndall calls a normal diamagnetic bar; the latter an abnormal one. The most perfect antithesis is observed in all cases between the deportment of the normal diamagnetic bar and a bar of soft iron; the forces which cause a deflexion of the former from right to left produce a deflexion of the latter from left to right. If the former take up a position of equilibrium from southwest to northeast the position taken by the latter will be from southeast to northwest; and throughout all the experiments the same opposition of action is exhibited. By mechanical means, an abnormal magnetic bar was obtained—a bar which set its length at right angles to the line joining the poles. The abnormal diamagnetic bar shows throughout a deportment precisely antithetical to that of the normal magnetic one; but when we compare the normal magnetic with the abnormal diamagnetic, or the normal diamagnetic with the abnormal magnetic, the deportment is in all cases perfectly alike. It is evident, therefore, that unless the influence of structure be attended to, the greatest errors and the most inaccurate conclusions may be founded on the deportment both of magnetic and diamagnetic bodies in the magnetic field; but the thing which chiefly concerns us is the strong presumption which the experiments justify, that whatever be the nature of the influences evoked in magnetic bodies by the action of currents, or magnets, or of both combined, to an influence, of the same nature but antithetical in its manner of distribution, the deportment of diamagnetic bodies is to be referred.

The next section of the inquiry imparted clearer knowledge as to the nature of diamagnetic action. Two helices were so placed that the ends of the soft iron cores which fitted into them were about six inches apart from centre to centre; the helices were at opposite sides of the plane which touched the ends of the cores. A helix of copper wire was introduced, and within it a bismuth bar 6½ inches long and four-tenths of an inch in diameter was freely suspended, so that the ends of the bar were opposite to those of the soft iron cores. A current being sent through the helix, if the bismuth bar within it were excited by the current it was probable that the nature of the excitement would manifest itself in the action of the magnets upon the diamagnetic body. By working delicately the most perfect mastery was obtained over the suspended bismuth; when the current through the helix flowed in a certain direction the ends of the diamagnetic bar were repelled by the electro-magnets; when the current flowed through, the helix was reversed, and the same ends were attracted by the magnets. The same effect was obtained when, instead of reversing the helix current, the polarity of the two magnets was reversed. On comparing the deflexions with those of soft iron, it was found that they were perfectly antithetical. The excitement which caused the ends of the iron bar to be attracted caused the ends of the bismuth bar to be repelled, while the excitement which caused the ends of the iron bar to be repelled caused those of the bismuth bar to be attracted.

All these experiments point irresistibly to the conclusion that, whatever the ideal magnetic distribution in iron may be, a precisely opposite distribution occurs in bismuth,—or, in other words, that the diamagnetic force is a polar force, but that the polarity is the reverse of magnetic polarity. If, however this be true, the bismuth bar, when the current circulates round it, must have its two ends in different states; but if in different states, then if we make the two poles acting upon the ends of the bar alike, we ought to have attraction at one end and repulsion at the other,—the result of their opposing actions being that the bar must remain undeflected. The decisive experiment has been made, and the result is in perfect accordance with the conclusion just expressed; when both magnetic poles are of the same name they completely neutralize each other. Following up this inductive reasoning, it is easy to see that, if what has been stated be correct, when we bring two magnets with poles of the same name to bear upon a bismuth bar, the direction of the force emanating from the two poles being the same, then the repulsion of one end and the attraction of the other, instead of, as in the former disposition, neutralizing each other, ought to constitute a mechanical couple tending to deflect the bar; and if two other poles of the same name, but of opposite names to the former two, be caused to act upon the bar the force of deflexion ought to be increased. In this form the experiment was made before the Section. Four magnets were made use of; the two poles to the left were of the same name, and the two to the right were of the opposite quality. The result completely coincided with the author's anticipations, and the bar was promptly deflected.

These experiments, without any exception, are all corroborative of the view, that diamagnetic bodies possess a polarity opposed to that of magnetic bodies,—but they do not prove that the physical theory of Weber is correct. Indeed, it is scarcely possible that this theory can stand in opposition to the experimental evidence which can be brought to bear against it. One consequence of this truly beautiful theory is, that when the particles of a diamagnetic body are caused to approach each other, the effect of their approximation will be to enfeeble the magnetic action along the line of approach. This view is opposed by the most direct experiments, which prove that the approximation of diamagnetic particles has an effect precisely opposite to that deduced from the theory.

Prof. W. Thomson remarked, that as early as the year 1847 he had published in the *Cambridge and Dublin Mathematical Journal* for May of that year, a theory of the phenomena presented by diamagnetic bodies in the neighborhood of a magnet, in which it was assumed as the only possible explanation of the repulsions observed by Faraday, that magnetic force induces upon a fragment of bismuth or of any other diamagnetic substance a polarity reverse to that which a piece of soft iron experiences in the same circumstances. In that paper the same set of mathematical formulæ are applied to either ferromagnetic (paramagnetic as they are now called) or diamagnetic bodies; the sole difference between the two cases being that a certain co-efficient, which measures the inductive capacity of the substance, has positive values for all ferromagnetics, and negative values for all diamagnetics. Since the time when that Paper had been published, he never had either expressed or felt the slightest doubt as to the certainty of the explanation of the elementary phenomena of diamagnetics which it afforded. Some views, founded on the impossibility of a perpetual motion, such, as it appears, would result from the actual substance of a diamagnetic solid receiving by induction a state of magnetization the reverse of iron in the same circumstances, which had been brought forward by Prof. Thomson at the Belfast Meeting of the British Association, had been referred to as opposed to the theory of the polarity of bismuth.

Prof. Thomson explained that those views led to the conclusion, not that bismuth experienced no magnetic polarity, but that the actual magnetization of its substance could not be the reverse of that of soft iron, and that the surrounding medium (whether it be air or what we habitually but falsely call vacuum) must experience magnetization similar to that of iron in the same position, and greater in degree than that of the bismuth. According to this conclusion, the definition of an ordinary diamagnetic is, a substance less magnetizable than air. Prof. Thomson further remarked, that he had not perfect confidence in the truth of this conclusion, as one of the assumptions on which the reasoning was founded admitted of doubt; but he had no doubt whatever of the resultant polarity of bismuth, however occasioned, being the reverse of that of iron. He concluded by expressing complete agreement with Prof. Tyndall on this point, and admiration of the remarkable combination of powerful and delicate apparatus, and the beautiful and well planned experiments by which Prof. Tyndall had so successfully demonstrated the antithesis between iron and bismuth to the Meeting.

ART. V.—*Reply to some remarks by W. H. Wenham, and Notice of a new locality of a Microscopic Test-object;* by Prof. J. W. BAILEY, U. S. Military Academy, West Point.

IN an article by W. H. Wenham, Esq., of London, published in the Quarterly Journal of Microscopic Science for July, 1854, I have noticed the following paragraph:

"These experiments [made by Mr. Wenham] will readily account for the difficulty of discovering the markings or structure of a severe test when mounted in balsam; for as thus seen it may be inferred that no aperture exceeding 85° can be made to bear upon it, and this is even supposing that the largest aperture object-glass that has ever been constructed is used. Such being the case I am somewhat puzzled at an announcement that appears to contradict this fact, coming from one that must be considered as authority in these matters. I refer to Professor Bailey, who, in a letter addressed to Matthew Marshall, Esq., dated January 20th, 1852, first speaks of an American object-glass of very large aperture (172½°) and its performance on the *most difficult tests known*, and then proceeds to say 'In all these cases (and in fact whenever I allude to a test-object) I mean the *balsam* mounted specimens. The *dry* shells I *never* use as tests.' This assertion seems to me to be extraordinary, and very like saying that an aperture of 85° or 90° will do every thing that is required. I have invariably found that when very difficult tests are mounted in balsam I cannot discover the markings, and certainly the reasons herein given will account for it. It is to be hoped that the American opticians have discovered some new and peculiar principle in object-glasses, that will render a smaller amount of aperture serviceable; but however this may be, I think that Professor Bailey's statement requires some explanation."—*Journ. Mic. Science, July*, 1854, p. 215.

It is apparent from the above that Mr. Wenham has convinced himself, both by "reasons" and experiment, that I *ought* not to have seen the markings on delicate test-objects when mounted in balsam; and that as he invariably found that he could not discover these markings, therefore some new and peculiar principle in object-glasses must have been discovered to account for the success of American opticians. In answer to this I would state that both in print, as well as in private letters I stand fully committed to the statement that I can resolve the most difficult tests known *even when mounted in balsam.* In 1849 I stated in this Journal, vol. vii, p. 268, that "the resolution of these tests mounted *dry* is so much easier than when in balsam, that objects thus mounted are of little value in testing the powers of lenses, although they may answer well when the end is to make out the real structure of the object itself." In fact I have up to this time met with no object which, when mounted *dry* presents sufficient difficulty to rank as a severe test-object, while there are many which when balsam-mounted become very satisfactory.

It is certainly no duty of mine to explain why Mr. Wenham has failed in his attempts to resolve the balsam-mounted specimens, particularly as the resolution of such tests is a matter of every-day amusement with microscopists in this country, and I believe Mr. Wenham does injustice to the microscopists and microscopes of London, in representing the English glasses as incapable of doing as much. That the English lenses are capable of performing well on balsam-mounted objects of considerable difficulty I know by my own trials, some of which are referred to in the following paragraph from a paper recently published in the Smithsonian Contributions to Knowledge, vol. vii, p. 14. "I would here state that in the spring of 1853 I resolved the Greenport Grammatophora [balsam-mounted] unmistakably by a $\frac{1}{4}$ of an inch objective made by Spencer, and subsequently by a $\frac{1}{4}$ recently made by Powell of London for Dr. Vanarsdale of N. York."

As Mr. Wenham does not mention the names of the test-objects employed by him, I cannot say that they may not be more difficult than any known to me; yet I feel no hesitation in challenging him to produce an object resolvable when dry, which I cannot resolve when balsam-mounted. I will also state that I, at present know of no test-object more difficult than a supposed variety of Grammatophora stricta, *Ehr.*, from Halifax, N. S. This is as much more difficult than the Providence Grammatophora, as the latter is more difficult than the Greenport specimens. As a supply of the last two varieties has been in London for two years they are probably known to Mr. Wenham and may have been subjected to experiments by him. That the balsam-mounted specimens of all these objects can be satisfactorily resolved is well known to American observers, and the following statement given by Judge A. S. Johnson in vol. xiii, p. 32 of this Journal, is fully confirmatory of my own experience. Speaking of a new object-glass of 174½° made in July, 1851, by Spencer, the following remarks are made:

"The light failing us as evening was approaching we did not try in this way either the Amici test or the Providence Grammatophora, but in the evening we saw both these objects [balsam-mounted] satisfactorily resolved into dots by unreflected oblique light from one wick of a common bed-chamber lamp, burning oil, a homely but very effective method of illumination for objectives of large apertures."

It appears then that the resolution of balsam-mounted specimens of difficult test-objects *can* be accomplished, in spite of Mr. Wenham's arguments and experience to the contrary. The error in his arguments will be sufficiently obvious to any one who will trace the course of a divergent pencil of rays *out of* the balsam instead of *into* it, as in Mr. Wenham's experiments, and it will then be seen that large angles of aperture are as useful for balsam-mounted specimens as for others. I leave the defense of large angles of aperture to the professed optician, being well satisfied that, notwithstanding the extraordinary attempts made by certain writers in England to underrate the value of the improvements made in this direction, no one who has once employed a properly corrected object-glass of large aperture will ever be satisfied with one of a different construction.

On a new locality of Microscopic test-objects.

In a Smithsonian memoir published in February, 1854,* I have described and figured a species of Hyalodiscus from Halifax, Nova Scotia, which appeared to me to be admirably fitted for a test-object, in as much as its circular form with radiant and curved lines of great tenuity proceeding in all directions renders it unnecessary ever to change the position of the shell when in the field of view in order to secure the best possible direction of the light. Whatever its position, on account of the perfect symmetry of its form and markings, some portion must always be in the best possible position with reference to the oblique light used for its examination. Unfortunately the Halifax specimens of this beautiful object appear to be quite rare, I am therefore happy to announce the discovery upon various Algæ from Monterey, California, of an inexhaustible supply of a species of Hyalodiscus closely allied to the Halifax species and answering equally well as a test-object. I find it so convenient as a test-object when *balsam-mounted* that I am sure it will find favor with lovers of the microscope.

* Notes on New Species and Localities of Microscopical Organisms, by J. W. Bailey, in Smithsonian Contributions to Knowledge, vol. vii, p. 14.

ART. VI.—*On the bearing of the Barometrical and Hygrometrical Observations at Hobarton and the Cape of Good Hope on the general theory of the Variations of Atmospherical Phenomena;* by Professor DOVE of Berlin.*

I HAD hoped to have prefaced this volume with a discussion of the meteorological observations made hourly at Hobarton from January, 1841, to September, 1848 (of which the abstracts were published in 1850 in the first volume of the Hobarton Observations), from the pen of Professor Dove, who had kindly undertaken, at the magnetical and meteorological conference at Cambridge in 1845, to participate to that extent in the reduction and application to theoretical conclusions, of the results of the Observations at the British Colonial Observatories; but M. Dove's appointment, on the death of Professor Mahlmann in November, 1848, to the charge of the meteorological observatories in the Prussian states has materially abridged the time at that gentleman's disposal, and he has found himself unable to complete the discussion he had undertaken for the present volume without occasioning an inconvenient delay in its publication; the discussion will therefore be prefixed to the fourth volume; but in the mean time Professor Dove has kindly furnished for this volume the subjoined remarks (written in German) upon the bearing which the barometrical and hygrometrical observations, at the Colonial Observatories at Hobarton and the Cape of Good Hope, have had on the general theory which professes to explain the physical causes of the variations which we observe in the atmospherical phenomena of the globe. The testimony borne by so eminent a meteorologist to the importance and value of this portion of the observations made at the British Colonial Observatories, cannot fail to be highly acceptable to the Government which instituted it, and to the public who have paid for these establishments, as it must be most satisfactory to the officers and to their assistants, by whose patient and unremitting labor facts of which the importance is thus recognized have been added to the foundations of meteorological science. The generalization in which M. Dove has applied them is remarkable alike for its extent and its simplicity, and I am glad of the opportunity of enriching this volume with so interesting a document. EDWARD SABINE.

Woolwich, March 17, 1853.

The establishment of meteorological stations in distant parts of the globe had, generally speaking, for its immediate object, so to complete the partial knowledge we already possessed of the phe-

* From "Observations made at the Magnetical and Meteorological Observatory at Hobarton, in Van Dieman Island," vol. iii, Introduction.—Phil. Mag., Oct., 1854.

nomena over a considerable portion of its surface, as to enable us to take a general view of their course over the whole globe; the result of those endeavors has even exceeded what was hoped for, as besides the information obtained respecting regions where our knowledge was most defective, fresh light has been thrown on those with which we had supposed ourselves already completely acquainted.

Meteorology commenced with us by the study of European phenomena, and its next principal extension was to phenomena observed in the tropical parts of America. If what is true of Europe were equally true of the temperate and cold zones of the earth in all longitudes, and if tropical America in like manner afforded a perfect example of the tropical zone generally, it would be of little consequence where the science of meteorology had been first cultivated; but this is not the case, and a too hasty generalization has led to the neglect of important problems, while others less important have been regarded as essential and placed in the foremost rank. It was necessary that the science should be freed from these youthful trammels, and this needful enfranchisement has been effected by the Russian and by the English system of observations. Russia has done her part in freeing the meteorology of the temperate and cold zones from impressions derived exclusively from the limited European type; and England, which by its Indian stations had undertaken for the torrid zone the same task of enlarging and rectifying the views previously entertained, has besides, by its African and Australian stations (Cape of Good Hope and Hobarton), opened to us the southern hemisphere, and first rendered it possible to treat of the atmosphere as a whole. I will now endeavor to show the importance of being enabled to take such general views, selecting as an example the annual variation of the barometer.

The study of the *annual* barometric variation had long been singularly neglected, while the *diurnal* barometric variation had had devoted to it an attention quite disproportioned to its subordinate interest in reference to the general movements of the atmosphere. This otherwise incomprehensible mistake is excused by the localities where nature had been first interrogated. As the diurnal variation had manifested itself with great distinctness and regularity in tropical America, it naturally presented itself as an object of interest in Europe also. The annual variation, on the other hand, is inconsiderable, both in Europe and the tropical parts of America; and thus, while atmospheric phenomena were treated simply as facts of which the periodicity alone was to be investigated, without seeking for physical causes, it was natural that a phenomenon, in which opposite effects resulting from two different causes counterbalance each other, should altogether escape notice. It is, perhaps, more remarkable that no surprise should have been excited when the atmospheric pressure was not found to diminish from winter to summer, with increasing heat.

When, by the labors of Prinsep more particularly, the phenomena of the tropical atmosphere in Hindostan became more known, there was seen to be a great difference between the barometric variation there and in tropical America; inasmuch as the Indian observations showed a decidedly well-marked annual variation. A new error was now fallen into, and it was supposed that the phenomenon did not extend beyond the torrid zone, and that it was an immediate consequence of the periodical change of wind, *i. e.* of the monsoons. This erroneous view was completely refuted when the barometric relations at the Siberian stations became known; for it was then found, that north of the Himalaya (which in the supposed hypothesis must have formed the limit of the phenomenon), the annual barometric variation was exhibited on a large scale, and over a region so extensive, that the shores of the Icy Sea itself could hardly be assumed as its boundary. A greatly diminished atmospheric pressure taking place in summer over the whole continent of Asia must produce an influx from all surrounding parts; and thus we have west winds in Europe, north winds in the Icy Sea, east winds on the east coasts of Asia, and south winds in India. The monsoon itself becomes, as we see, in this point of view only a secondary or subordinate phenomenon.

I have endeavored to establish the reality of the above phenomenon and its climatological bearings in several memoirs; and I must refer for the numerical values to Poggendorff's *Annalen*, vol. lviii, p. 177; vol. lxxvii, p. 309; and to the *Berichte* of the Berlin Academy, 1852, p. 285. I will here embody the results in distinct propositions, in order to show, in connexion therewith, the importance of the bearings of the Hobarton observations.

1. At all stations of observation in the torrid and temperate zones, the elasticity of the aqueous vapor contained in the atmosphere increases with increasing temperature. In the region of the monsoons this increase from the colder to the warmer months is greatest near their northern limit. Hindostan and China present in this respect the most excessive climate. No differences of similar magnitude are found in the southern hemisphere. The form of the curve of elasticity of the aqueous vapor shows, however, a less decidedly convex summit in the region of the monsoons than beyond it, having in that region rather the character of a flattened summit or table-land, the elasticity continuing nearly the same throughout the period of the rainy monsoon. Near the equator the convex curve of the northern hemisphere becomes, first flattened, and then gradually transformed into the concave curve of the southern hemisphere. In the Atlantic this transition takes place in a rather more northerly parallel. In regard to the magnitude of the annual variation, the following rule

appears generally applicable in the torrid zone: the annual variation is considerable at all places where equatorial currents prevail when the sun's altitude is greatest, and polar currents when the sun's altitude is least; and inconsiderable wherever the direction of the wind is either comparatively constant throughout the year, or where it changes in the contrary sense to that above described. At the last-named class of places the rate of decrease in the mean annual tension of the aqueous vapor with increasing distance from the equator is more rapid than in the first class.

2. At all stations in Europe and Asia the pressure of the dry air decreases from the colder to the warmer months, and everywhere in the temperate zone has its minimum in the warmest month.

3. If we compare the annual variation of the pressure of the dry air in northern Asia and Hindostan with the variation in Australia and the Indian Ocean, we shall be satisfied that something more takes place than a simple periodical change of the same mass of air in the direction of the meridian, between the northern and southern hemispheres. From the magnitude of the variation in the northern hemisphere, and the extent of the region over which it prevails, we must infer that at the time of diminished pressure a *lateral* overflow probably takes place; that it actually does so may be considered as proved for the northern part of the region, by the fact that at Sitka, on the northwest coast of America, the pressure of the dry air *in*creases from winter to summer. It is not probable that the overflow takes place exclusively to the east, it probably occurs also to the west; and on this supposition the small amount of the diminution of the pressure of the dry air from winter to summer in Europe would be caused, not solely by the moderate amount of the difference of temperature in the hotter and colder seasons, but also by the lateral afflux of air in the upper regions of the atmosphere tending to compensate the pressure lost by thermic expansion. As at the northern limit of the monsoon, at Chusan and Pekin, the annual variation of the pressure of the dry air is most considerable, while at the northern limit of the trade wind in the Atlantic Ocean, *i. e.* at Madeira and the Azores, it is very small, it is probable that there is in the torrid zone also a lateral overflow in the upper strata of the atmosphere from the region of the monsoons to that of the trades.

4. From the combined action of the variations of the aqueous vapor and of the dry air we now derive immediately the periodical variations of the whole atmospheric pressure. As the dry air and the aqueous vapor mixed with it press in common on the barometer, so that the upborne column of mercury consists of two parts, one borne by the dry air, the other by the aqueous vapor, we may well understand that as with increasing tempera-

ture, the air expands, and by reason of its augmented volume rises higher and at its upper portion overflows laterally,—while at the same time the increased temperature causes increasing evaporation, and thus augments the quantity of aqueous vapor in the atmosphere,—so it naturally follows that the composite result in the periodical variations of the barometric pressure should not everywhere bear a simple and immediately obvious relation to the periodical changes of temperature. It is only when we know the relative proportions of the two variations which take place in opposite directions that we can determine whether their joint effect will be an increase or a decrease with increasing temperature,—whether in part of the period the one variation may preponderate and in other parts the other variation. The following are the results which we are enabled to derive from observation.

5. Throughout Asia, the increase in the elasticity of the aqueous vapor with increasing heat is never sufficient to compensate the diminished pressure of the dry air, and the annual variation of barometric pressure is therefore everywhere represented in accordance with the variation of the pressure of the dry air, by a simple concave curve having its lowest part or minimum in July. The observations in Taimyr Land, at Iakousk, Udskoi and Aiansk, show that this is true up to the Icy Sea on the north, and to the sea of Ochotsk on the east. On the west a tendency towards these conditions begins to be perceived in European Russia in the meridian of St. Petersburg, and becomes more marked as the range of the Ural is approached. On the Caspian and in the Caucasus the phenomenon is already very distinctly marked; its limit runs south from the western shore of the Black Sea, so that Syria, Egypt and Abyssinia fall within the region over which it prevails. Towards the confines of Europe there is almost everywhere a maximum in September or October, the barometric pressure increasing rapidly from July to the autumn. This maximum is followed towards the latter part of the autumn by a slighter inflexion or secondary minimum; it is only beyond the Ural that the curves become uniformly concave, with a single summer minimum and winter maximum, which character they retain throughout the rest of the Asiatic continent, even to its eastern coast. In winter the absolute height of the barometer at the northern limit of the monsoon is very great. The still considerable amount of the annual variations at Nangasaki, and the little difference between the curve of Manilla and that of Madras, show that the region in question extends beyond the eastern coast of Asia into the Pacific Ocean; in higher latitudes, however, its limits appear to be reached in Kamschatka. As the annual variation, which is greater at Madras than at Manilla, is found greater at Aden than at Madras, the western limit of the region would appear to extend far on the African side.

6. In middle and western Europe the barometric pressure appears to decrease everywhere from the month of January to the spring, usually attaining a minimum in April; it then rises slowly but steadily to September, and sinks rapidly to November, when it usually reaches a second minimum. In summer, therefore, the whole atmospheric pressure gains more by increased evaporation than it loses by expansion. This over-compensation is probably to be explained, as we have seen above, by the lateral overflow received in the upper regions from Asia. In Sitka the whole annual curve is convex, a result only found in Europe at considerable mountain elevations, where it is a consequence of the expansion, and extension upwards, of the whole mass of the atmosphere in summer.

7. The region of great annual barometric variation, on the Asiatic side of the globe where *monsoons* prevail, extends much further to the north in the northern hemisphere, than it does to the south in the southern hemisphere; for the variation reaches its maximum at Pekin, while at Hobarton, in nearly a corresponding latitude, it has already become inconsiderable; and it is generally greater in the northern than in the corresponding southern latitudes. The exact contrary is the case on the Atlantic side and in the region of the *Trades;* for here the annual variation, though nowhere very considerable, is decidedly greater in the southern than in the northern hemisphere, as is shown by the results of observation at the Cape, Ascension, St. Helena, Rio Janeiro, and Pernambuco, compared with the West Indian Islands and the southern parts of the United States. Hence it follows, that if we compare places in the same latitude, we find but little difference between the annual variation in the southern Atlantic and southern Indian oceans, while in the northern hemisphere we have in the same latitude the very large annual variation in the north part of the Indian and in the Chinese seas, and the almost entire absence of annual variation in the Atlantic (compare Chusan with the Azores and Madeira). The explanation of the last named phenomenon, *i. e.* that of the northern hemisphere, by a lateral overflow in the upper parts of the atmosphere, seems so direct, that I think we may pronounce the irregular form of the annual barometric curve in the West Indies to be a secondary phenomenon, the primary causes of which must be looked for on the east.

8. It is known that in the eruption of the Coseguina on the 20th of January, 1835, when the isthmus of Central America was shaken by an earthquake, not only were volcanic ashes carried to Kingston in Jamaica, a distance of 800 English miles in the opposite direction to the trade wind, but some of the same ashes also fell 700 miles to the *westward*, on board the Conway, in the Pacific Ocean. We infer, therefore, that in

the higher regions of the atmosphere in the tropics the air is not always flowing regularly from S. W. to N. E., but that this usual and regular direction is sometimes interrupted by currents from east to west. I think I have indicated the probable cause of such anomalous currents in the above described barometric relations of the region of the monsoons compared with that of the trades. If we suppose the upper portions of the air ascending over Asia and Africa to flow off laterally, and if this takes place suddenly, it will check the course of the upper or counter current above the trade wind, and force it to break into the lower current. An east wind coming into a S. W. current must necessarily occasion a rotatory movement, turning in the opposite direction to the hands of a watch. A rotatory storm moving from S. E. to N. W. in the lower current or trade, would in this view be the result of the encounter of two masses of air impelled towards each other at many places in succession, the further course of the rotation (originating primarily in this manner) being that described by me in detail in a memoir "On the Law of Storms," translated in the Scientific Memoirs, vol. iii, art. 7. Thus it happens that the West India hurricanes and the Chinese typhoons occur near the lateral confines on either side of the great region of atmospheric expansion, the typhoons being probably occasioned by the direct pressure of the air from the region of the trade winds over the Pacific into the more expanded air of the monsoon region, and being distinct from the storms appropriately called by the Portuguese "Temporales," which accompany the outburst of the monsoon when the direction of the wind is reversed. The fact of the rotatory storms being of much more rare occurrence in the South Atlantic Ocean arises from the more equal distribution of the periodically diminished atmospheric pressure in the southern as compared with the northern hemisphere. Here, therefore, the rotatory storms take place principally in the monsoon itself.

9. It is evident that the unsymmetrical distribution of land and sea, which gives rise to the abnormal variations in the forms of the isothermal lines, is at the same time the principal cause of the movements of the atmosphere. Thus the monsoon is but a modification of the trade wind, of which the cause is to be sought in part beyond the tropic. The region of great thermic expansion of the air in summer in the interior of the continent of the Old World presents all the characteristic marks of the region of calms, being a centre towards which all adjacent masses of air are drawn. Hence there is no complete sub-tropical zone, in the sense of a zone encompassing the globe. The region over which the heated air ascends does not therefore move up and down, or north and south, parallel with the sun's change of declination, but has rather a kind of oscillatory movement, in which the West Indies represent the fixed point, and the greatest ampli-

tude of oscillation is on the side of India. The northern excursion is much greater in the northern hemisphere than is the southern excursion on the side of the southern hemisphere. The European atmospheric relations, especially in summer, are therefore essentially of a secondary nature; and we must regard the little alteration in the atmospheric pressure in the course of the year in Europe as a secondary result, of which the explanation would not have been possible without the observations from Asia and Australia.

Berlin, January 5, 1853.

ART. VII.—*On the Composition of Eggs in the series of Animals*—PART I. By A. VALENCIENNES and FREMY.*

ANATOMISTS who undertake new researches on the eggs of animals, are obliged, while extending their investigations to the different species of the animal series, to recur to the periods, now distant, of the publications of Prevost and Dumas, and of Charles Ernest Baër. The discovery of the former confirmed the opinions of William Cruikshanks, founded on observations and exact experiments; and that of M. Baër, who succeeded in seeing the first rudiments of the ovule, even under the stroma of the ovary of mammals, made one step more in Ovology.

That distinguished anatomist, while aiming to follow the evolution of the fœtus, not only in the eggs of animals of that class, but in the different members of the animal kingdom, did not attempt to ascertain the nature of the liquids, more or less dense, of the egg, nor of those bodies held in suspension or dissolved in these liquids.

The same direction was pursued by those anatomists who have treated this subject before and after M. Baër. We should digress too much if we were to give a history of their successful labors. We believe it useful however to recall the course followed by the clever anatomist of Kœnigsberg and by his successors, in order to explain how it is that no one has yet investigated what the microscope has discovered in the vitellus (the yolk) of different eggs. It seems to us beyond a doubt that M. Baër saw the granular yolks of different kinds of ray fish and sharks, without studying them in detail. He did not try to discover their real nature by the aid of chemical analysis. He limited himself in fact, to saying that the yellow consists of a viscous liquid, of colorless grains of albumen, and of fat almost always divided into minute drops. This yellow is surrounded by white, but M. Baër did not try whether it would coagulate

* Translated from the Journal de Pharmacie, &c., May, 1854, p. 321, by Dr. J. Rosengarten, for this Journal.

like that of the egg of a chicken. In a word, this investigator saw in the eggs of these cartilaginous fishes, and in those of other animals, a mixture of principles as in the eggs of birds, always consisting of a yolk or vitellus, covered with white liquid albumen, and all contained in an external membrane as much varied in its nature as in color. We have reason for believing too, that M. Vogt perceived some vitellin grains in the yolk of the toad, Palytes obstetricans, *Dum.* He is however, less precise than M. Baër. It is also believed that M. Strauss saw the vitellin granules, of which we shall speak in our second paper, since he described in his beautiful work on the anatomy of the cockchafer, the yolk of eggs of these Coleoptera, as formed of a liquid pulp, composed of granules, and showing on the surface of the envelop of the egg a layer of globules. There are allusions to these granules in the work of Baudrimont and Martin Saint-Ange, which was crowned by the Academy of Sciences. But these authors did not separate them from the rest of the yolk to make them the subject of special study; they pointed them out in the midst of the drops of oil which swim in the yellow of the eggs of frogs. Other naturalists who have studied the eggs of different Annelids, Helminths, Insects, Arachnids, Crustacea, Molluscs (either Cephalopods, Gasteropods or Acephalous), speak of globules, without distinguishing them from drops of fat, and, which is more important for the subject of this article, without marking any vitellin substance.

M. Dumas and Cahours were the first who clearly distinguished in the egg of a hen, a particular proximate principle, the yolk, characterised by its physical properties and by its composition as deduced from chemical analysis. Their researches were not pushed further, and they were satisfied by calling by the same collective name of egg, all the products of the ovary that serve in any animal, after its fecundation, for the reproduction of individuals like the parent animal which secreted them.

On examining attentively the eggs of numerous oviparous animals, anatomists however have observed marked differences, which prove that these reproducing bodies are as varied as the animals to which they give birth. Thus,—only to cite a few facts,—the absence of the allantoid in the eggs of oviparous animals living in the water, was long ago remarked; the want of chalazes, the thin vitellin membrane detected with difficulty under the microscope taking its place; and as, one of us has observed, many kinds of eggs do not harden by cooking in boiling water.

The Academy long ago acknowledged the necessity of calling the attention of men of science to the investigation of this subject, by proposing to the meetings, questions relating more or less definitely to the particular composition of eggs. It has been fortunate to find in many communications addressed to it, a portion of the desired answers.

Feeling ourselves the importance of making additions to the researches already brought forward on the composition of eggs, we have undertaken this task together, the questions which it raises being partly zoological and partly chemical.

A subject so vast, which needs the continuous study of eggs of animals belonging to different classes of the animal kingdom, cannot be exhausted in one article; we are far too, from considering our researches as completed.

We propose in this memoir, to describe the differences which exist in the composition of eggs, and to lay down some general principles, to be developed in subsequent communications.

1. *Eggs of Birds.*

What we have said at the commencement of this article sufficiently explains our silence as to the composition of hen's eggs during the evolution of the fœtus, and as to former researches relative to the membranes which envelop the first formation of the chicken within the egg. We will here examine only the nature of the two substances, the white or albumen, and the yellow or vitellus, in order to start from this point of comparison in studying the eggs of other animals. We shall not follow strictly the order established by zoologists for the animal series, though we shall not depart widely from that order.

The composition of birds eggs has been clearly established by numerous authors, first by Vauquelin, Bostock, and then by Chevreul, John, Dumas and Cahours, Lecanu, Gobley, Martin St.-Ange and Baudrimont, Scheerer. And in this part of our researches, we are satisfied to confirm the exactness of the leading facts announced by the observers we have cited, and to determine with precision the specific characters of birds eggs.

The white of birds egg is considered by almost all chemists as a principle itself pure, though this white has in it various salts and a sulphurous body which can be separated from the albumen by different reagents without producing the decomposition of that substance, as was long ago shown by Chevreul.

In examining the white taken from eggs of different kinds of birds, we have often noticed that this body has varying properties. In some kinds, it is almost fluid; in others, it possesses a gelatinous consistency. The white of the egg of a hen is, after boiling, opaque, and of a pure color, white and solid. That of the lapwing becomes after cooking, transparent, opaline, greenish, and so hard that it may be cut into little stones, used in certain parts of Germany for common jewelry.

These peculiarities are not enough to prove that the white of birds eggs is formed of different albumens, but they seem to show that attentive researches will enable us to point out new properties in these albumens, which have hitherto escaped chemists.

When endeavoring to follow in another paper certain of the modifications which are produced in the egg during incubation, we shall then return to the peculiarities which relate to the constitution of albumen, and we shall examine, while supported by the labors of M. Chevreul, whether soluble albumen is to be taken as a pure proximate principle or not.

The yellow of a bird's egg is formed of a viscous liquid, holding suspended in it a fatty phosphuretted matter which shows some analogy to the cerebral fat. The viscidity of this liquid is due to the presence of an albuminous substance which has been carefully studied by Dumas and Cahours, and which chemists call *vitellin.* Vitellin is always found in the yellow of a bird's egg, associated with a certain quantity of albumen. The presence of albumen in the yolk of birds led us to modify the process which up to this time has been used in preparing vitellin. This material was obtained by drying with ether the yolk of a hen's egg previously cooked. To prepare vitellin, we treat the yolk of a hen's egg with cold water: the albumen is left dissolved in the water, while the vitellin is precipitated. The latter, washed with water, alcohol and ether, is nearly pure vitellin. While this substance thus obtained shows all the characteristics which have been marked by Dumas and Cahours, it offers so great analogy to albumen, that the presence of a certain portion of the latter substance does not sensibly modify its composition and properties. In this way we have proved that vitellin entirely freed from albumen, dissolves like albuminous substances, in boiling hydrochloric acid, producing a beautiful violet-blue color.

The yellow of a bird's egg exposed to damp air grows hard quickly, because the atmospheric moisture acting on the yolk, causes the precipitation of the vitellin; this solidification is first observed on the surfaces of the liquid which are in contact with the air. While examining the properties of the albuminous body which characterises the yolk of bird's eggs, and which has received the name of vitellin, we must first point out the resemblance between it and fibrine. The elementary analyses of these two substances give the following results:

	Fibrin.	Vitellin. I.	Vitellin. II.
Carbon,	52·5	52·26	51·60
Hydrogen,	7·0	7·24	7·22
Azote,	16·5	15·08	15·02
Oxygen and Sulphur,	24·0	25·42	26·16
	100·0	100·00	100·00

Vitellin and fibrin may be said to have the same composition; for with two bodies of this kind, uncrystalline, insoluble in water, and which consequently are purified with difficulty, what chemist can answer, in an organic analysis, for the one-hundredth part of azote? As to the chemical properties of these two bodies, it should be remembered that they are almost identical. They are in fact, equally soluble in the alkalies; hydrochloric acid dissolves them alike, producing the characteristic blue. Before considering vitellin and fibrin as identical, we ought to submit vitellin to a test which in an unequivocal manner characterises fibrin. We know, after Thenard's beautiful observations, that fibrin has the property of decomposing oxygenated water and disengaging oxygen, like metallic oxyds; the azote obtained from the yellow of egg, should decompose oxygenated water, like fibrin, if it were identical with the latter. This experiment, made several times, has always given a negative result. Hence the azote-matter which exists in the yellow of bird's eggs, and which is precipitated when the yolk is diffused in a considerable amount of water, presents, it is true, an evident analogy to the fibrin of blood, but still differs from it in certain characteristics.

Reviewing the facts as to bird's eggs, established by us or by earlier observers, we may say, that aside from all the zoological and anatomical characters of the shell, its form and its varied color, the membranes, those formed at the moment of laying the egg or those which are developed during incubation,—the two essential constituents, prepared by nature to nourish the chick in the egg, may always be known by the following characteristics.

1st. The white, very rich in albuminous matter, is plainly separated from the yellow by the vitellin membrane.

2d. The yellow, principally made up of phosphuretted fatty matter, of a little albumen, of different salts, gives an abundant precipitate of vitellin when suspended in enough water. This substance, perfectly characteristic of birds eggs, is not met with in any other kind of eggs.

2. *Eggs of Fishes.*

The extensive family of fish with cartilaginous skeletons, the "Plagiostomes" of M. Duméril, has been divided by recent ichthyologists into many families. The Ray of Linnæus and of Lacépède constitute the family Raiidæ; the torpedos or electrical fish constitute the family Torpedinæ; the race of sharks subdivided into many others, is now the family Squalidæ. In the comparative study of these three families in connection with ovology, there are found fishes which are oviparous and ovoviviparous. We have mentioned the researches of M. Ch. Ern. Baër on the nature of the liquids contained in the egg of the Cartilaginæ, where he saw granules which he took for corpuscles of albumen. But beyond proving that these grains are different in substance from albumen, neither he nor other anatomists have yet studied the nature of the white or of the yellow of the eggs of these Cartilaginæ. This it is which we have attempted.

Of the Eggs of the Ray.—The new laid egg of a Ray is covered with a shell of a bronzed green, whose tissue is made up of short felty (*feutrées*,) fibres; its general form is a rectangle, more or less elongated and curved on both sides; each angle is prolonged in a crooked tongue (languette). The longer side of this rectangle extends into a very fine yellowish membrane, which looks like the shell. Carefully taking the egg out of the oviduct, the membranes are seen secreted in the interior of the great white gland which encloses the origin of the oviduct. The surface of each of them distended under water, is more than twice that of the shell.

In opening this egg, there is a good deal of yellow contained in a transparent gelatinous mass which represents the white of a hen's egg, although it is entirely different. The yellow is in the middle of this mass, in one of the transparent cells of the white, for the yolk, as M. Baër has very rightly said, has not a vitellin membrane of sufficient strength to be observed under the microscope, and still less to separate the yellow from the white, so as to isolate it. So that in order to get the yellow matter entirely pure, it must be taken in an ovula nearly ready to detach itself from the ovary and to enter into the oviduct. We may now remark that this gelatinous white portion does not at all resemble the white of birds eggs: it does not dissolve in water, it does not either under the action of heat or acids, coagulate comparably with that of ordinary albumen. Examining this jelly carefully, we have seen that it was formed by vesicles, whose elastic membranes contain a liquid, which dissolved, showed only traces of albumen. When these vesicles are exposed to the air for several days, they become empty, as it were, losing their gelatinous consistency, and then produce a slightly albuminous liquid which holds suspended some transparent membranes. Alcohol equally destroys the gelatinous mass by stopping the coagulation of the membranes. Evaporating the white of the Ray's egg in vacuo, it is seen that it contains only traces of organic substances. The white of a Ray's egg, then, proportionably small compared with the yellow, is different in all its relations from the albumen of birds eggs.

The study of the yellow of the Ray's egg ought to establish differences still more remarkable between birds eggs and those of cartilaginous fishes. The yellow of the Ray's egg, under the microscope, shows that it is formed of a rather fluid liquid, holding suspended drops of a fatty body of light yellow, and a considerable quantity of small white transparent grains of a regular form. We have examined these grains in the different sorts of Ray-fish which abound in our Paris markets.

Eggs of the Torpedo.—We have examined many torpedos from the shores of La Rochelle, through the kindness of Dr.

Sauvé, a physician of that city. We have discovered that these fish, while like the Ray in general form, have quite another mode of generation, and in this respect, more nearly resemble the larger number of Sharks. Torpedos are ovoviviparous. We found in the oviducts of one, eight small ones, four on each side. Each fœtus when nearly born, had in the interior of the abdomen, a considerable portion of its vitellus (yolk). We were able to examine this liquid, and we found in it, with the microscope, grains similar in appearance to those in the Ray's eggs, though their forms were distinct. This is the only part of the Torpedos' egg we are as yet acquainted with. We cannot therefore say anything of the white of the eggs of this species of Cartilaginæ and of their shell.

Eggs of the Bounce Shark, (Catulus major, &c.)—The eggs of our Bounce are rectangular, much longer, but much narrower than those of the Ray. Its shell is hard, resisting, yellowish, horny, like the filament which starts from each angle. One is usually found in each oviduct, as in our Ray, to which another soon succeeds, after the laying of that which is completed in the belly of the female. The ovary of the Bounce, narrower than that of the Ray, is like it also in its structure; and under its stroma, there is a greater or less number of ovules of very different sizes, from those which are hardly perceptible to those vitellin spheres ready to detach themselves from the ovary to enter the oviduct. In opening an egg, the vitellus appears to occupy the greater part. Its vitellin membrane is even more difficult to see than that of the Ray: the white is more viscous, the membrane containing it much more delicate; the liquid, however, only contains some traces of albumen. Alcohol produces similar destruction of the gelatinous mass, stopping the coagulation of these membranes. The white of an egg of a Bounce is therefore very much like that of an egg of a Ray. The yellow of this egg resembles very considerably that of a Ray's egg. The very fluid liquid which composes it, holds suspended drops of yellowish oil, and a quantity of little white transparent grains, regular in form, but differing from that of the grains of the different sorts of Rays which we have examined.

Eggs of "Melandres," (Squalus galeus, *Lin.*)—If the Bounce shows the same ovological condition as the Ray, other sharks are like the torpedos, for they are, like these, ovoviviparous. We found in these eggs, by the microscope, a large quantity of little grains of a different form from that of our Ray, but still visibly analogous.

Eggs of the Round-Fish, (Squalus mustelus.)—Another sort of shark, the Emisole (Squalus mustelus, *Lin.*) gave us quite a number of ovules; for gestation was not far enough advanced to engage the eggs in the oviduct. This fact, fortunate for our labor, showed us that the yellow of the eggs of sharks, still in the ovarian capsules, offers the same composition as those of Ray's eggs. Our observations are then established wholly by comparison.

Eggs of the Angel-fish, (Squatina angelus, *Dum.*)—We were not able to obtain more than one female this year, and all its ovules were still in the ovarian capsules, under the stroma of the ovary, which, in form, texture and even color, is more like those of the Ray than the sharks. We carefully gathered the yolks about to develop; we found in them, as in the former, a fatty matter divided into drops, swimming in a viscous albuminous liquid, with a great number of grains of peculiar form.

3. *Of Ichthin.*

Our observations on the eggs of so varied species and kinds of Cartilaginæ, bring us to the immediate analysis of the different yolks. After ascertaining that the grains suspended in the liquid were insoluble in water, and that this liquid did not thicken with water, the next step became very simple.

After taking proper precautions for running the yolk without mixing, into a large quantity of distilled water, the grains, which were denser than the water, fell to the bottom, and were washed by decantation, till the washing-water had no more trace of albumen or of salty matters. The grains were entirely freed from the fatty matter by successive washings in alcohol and ether. There remained after this treatment, a large quantity of grains, from which it is easy to get in some hours, several hundreds of grammes, which present under the microscope, every characteristic of absolute purity.

The analysis which we will now briefly describe, then showed us that the vitellus of an egg of the Cartilaginæ is formed of an albuminous liquid, holding in solution some mineral salts, principally chlorids and phosphates, and suspended white grains of an even and regular form in each species but varying in one species from another, and mixed with a small quantity of phosphuretted fat. This fatty matter is soluble in alcohol and ether; it forms with water a sort of mucilage; it shows some analogy to the fat-acid which is found in the stag, described by one of us as oleophosphoric acid. As for the white grains, they seem to us to constitute quite a new principle, whose properties and composition we shall describe as ichthin. Ichthin is pleasant to the touch, and presents to a certain extent, the aspect of starch. We obtained it by our process, pure, under the form of granules from different species of Cartilaginæ.

From the Thornback or Clavated Ray (Raia clavata, *Lin.*), the grains of ichthin obtained from the yolk of a freshly laid egg, appear in the form of little rectangular tables, with round edges and obtuse angles ; the largest are four hundredths of a millimetre, perfectly transparent, but distinctly marked edges. They are identical in the yolks in the process of formation, and in the ovarian vesicles, and whatever the size of these ovules from those which are only $0^{m}\cdot01$ in diameter, to the largest which are $0^{m}\cdot03$. In the smaller ovules with diameter varying from $0^{m}\cdot001$ to $0^{m}\cdot005$, the grains have the same tabular shape ("en tablettes,") but they were much smaller, and did not exceed two hundredths of a millimetre in length. Generally these grains are of one dimension in each ovule. But the differences we are about to point out, show that the grains enlarge with the development of the ovules, and that the vitellus, when they are little developed, has much smaller grains of ichthin than with those which are nearer the oviduct or more in the egg. The Ray from which these yolks were taken were hardly $0^{m}\cdot50$ long not counting the tail, with a weight of 4 or 5 kilogrammes. In our many examinations of different grains of ichthin, we met occasionally with some little tables almost square, others regular or irregular pentagons ; these grains have a tendency to separate. We have not yet been able to see whether these different forms are due to some constant cause, or whether they are owing to simple accidental variations, so common in even the most elementary natural productions. We tried to crush these grains in an agate mortar, and found that generally they break according to the axes of the rectangles of these 'tablettes,' and not according to their diagonals. We studied the grains of yolk developed in the largest of our Ray such as in our markets go under the name of the soft or white Ray. This is the Raia oxyrhynchus of Linnæus. We must not forget to remark that individuals of this kind of Ray are even two metres long, not counting the tail, that they attain the weight of 100 kilogrammes, and yet the eggs of this Ray give the smallest grains of ichthin. Those of the spiked Ray (Raia fullonica,) and those of "la raie ronce" (Raia rubus,) are very much like those of "la raie bordée ;" the most noticeable difference consists in their smaller dimensions. The largest are only three hundredths of a millimetre. In the eggs of these two sorts of Ray, the grains are very often regular ellipses, but the rectangular form is still more common. The vitellin grains of the marbled torpedo (Torpedo marmorata,) from La Rochelle, are very different in shape from those of the Ray, the former being elliptical or circular: there are no rectangular grains; their transparency and their other physical properties are the same. They are only two hundredths of a millimeter, but it is not to be forgotten that the Torpedos are never large. Ichthin of sharks is in larger grains, more elongated than those of the Ray, and of a very long oval shape. We have noticed, too, some variations in the form. In a careful microscopic examination, we saw one of these ovoid grains pointed at both ends. Another had the two long straight sides, terminating in two isoceles triangles; it was the figure of an elongated hexagon. The hound-fish (Squalus mustelus, *Lin.*), smaller than the "Melandre," has grains of ichthin almost as large as those of the latter. They are five hundredths of a millimetre; their form is different from all the others. These grains are round, but often united in the most varied forms. The Bounce (la ronsette, Squalus canicula, *Lin.*) has rectangular grains and obtuse angles, very like those of the Ray; their longer side is four hundredths of a millimeter. The angel-fish (l'ange, Squatina angelus, *Dum.*) has as large grains as the Squalus mustelus; they are elliptical like those of the shark, and as large, for they are six hundredths of a millimeter. We conclude then, from the comparison of the forms of these grains in the different species cited, that the oviparous species like the Ray and Bounce, have more or less rectangular grains, and are very much alike, while the Cartilaginous viviparous species, like Torpedos and Sharks, generally have oval grains; that if the development of the ovula influences the largeness of the grains of ichthin, the size of the fish has no effect on the size of the grains.

The grains of ichthin are insoluble in water, alcohol and ether; they are completely transparent, and do not become opaque by being kept even for a long time, in boiling water; hydrochloric acid dissolves them without producing a violet color: the two latter properties clearly establish the difference between ichthin, albumen and vitellin. All the concentrated acids dissolve ichthin; when they are dilute, they do not act upon it, excepting acetic and phosphoric acids, which immediately dissolve grains of ichthin, even when greatly diluted with water. Solutions of potash and soda are slow solvents of ichthin. It is insoluble in ammonia. Grains of ichthin when burnt, leave no ashes. When the ease with which ichthin can be obtained from the eggs of certain fish is considered, and when it is seen that grains of ichthin, by the regularity of their form, offer all the characteristics of a really pure principle, it is impossible not to consider it as one of the most interesting substances in the animal organization. Ichthin, when analyzed, gives the following composition:

	I.	II.	III.	IV.		V.	VI.
Amount of material,	0·452	0·427	0·282	0·228		0·332	0·406
Water, - - -	0·275	0·300	0·195	0·150			
Carbonic acid, - -	0·845	0·800	0·520	0·420			
					Azote,	0·049	0·062

The results give the percentages:

Carbon, - - - - -	50·9	51·0	50·2	50·2
Hydrogen, - - - -	6·7	7·8	7·6	7·3
Azote, - - - - -	14·7	15·4		

Its centesimal composition will then be:

C 51·0 H 6·7 Az 15·0 Ph 1·9 O 25·4

It is easy to believe, that these regularly formed tables are small crystals. To remove doubts in this respect, we have had recourse to the kindness of M. de Sénarmont, who examined our grains with a polarizing apparatus. This proved to him and to us, that the grains of ichthin are not crystallized.

ART. VIII.—*The Arabic or Indian Method of Notation;* by THOMAS H. MCLEOD.

THE subject of arithmetical notation in its relation particularly to the Arabic or Indian, the Roman, and Grecian systems, has arrested the attention of mathematicians from the earliest period of modern mathematical investigation; but the mechanical structure, especially of the Indian, seems to have been overlooked, as well as the probable circumstances under which that structure originated.

Barlow, in his Theory of Numbers, presents the following equation,

$$N = ar^n + br^{n-1} + cr^{n-2} + \&c. \ldots . pr^2 + qr + w,$$

where r may be any number whatever, and a, b, c, &c. integers less than r, as expressing the scheme of the Indian method. It is undoubtedly a formula by which that method may be explained; but that it exhibits its simple primitive mechanical structure, may be justly questioned. For in the first place it does not show the first position of 0 (zero) with any reliable certainty: the only place we are left to refer it, from the explanations, is to 10, where it appears on the right of 1, which we apprehend is not its first place; secondly, r appears in the form of a power, which is unquestionably true, but accidental; thirdly, it is asserted that r may be any number whatever, yet upon examination it will be found always to assume the form 10, whatever be its significance in the denary measure; and finally, it cannot be in any manner supposed that the scheme had its origin in philosophy, as the formula would seem to indicate, but that it arose out of the circumstances and necessities of the people from whom it sprung.

Having finished these few restrictions, of which more might be made, concerning what mathematicians have said upon this subject, we shall proceed to explain what we consider to be the simple primitive structure of the Indian method, and afterwards allude by way of comparison to that of the Grecian and Roman methods.

The first peculiarity of the Indian method is its 0 (zero), which stands as the *origin* of the scheme, as will be seen by writing it out thus:

0, 1, 2, 3, 4, 5, 6, 7, 8, 9,

where it evidently appears in its first place. The next characteristic worthy of note, is the 10, which does not appear among the above figures; it is evidently made up of 1, and 0, but how from this circumstance does it get its significance? We conceive the way to be this: It is well known to land-surveyors and other lineal measurers, that the place where the measuring commences is but a point and has no lineal significance, and that the first unit of measure is at the distance of a unit from that point, and the second at two measures, and the third three, &c.; i. e. in measuring land the first pin is stuck at the distance of one chain, or measure, from the place of beginning, the second at the distance of two chains, the third at the distance of three chains, and so on. If then the place of beginning be represented by 0, and the several distances respectively by 1, 2, 3, 4, &c., the whole will be properly expressed. But when the pins are all exhausted and a *tally* is to be made, how is it to be done? Very naturally by placing down a 1, and a 0 (zero) (which has no lineal significance) to the right; the fact is thus recorded, and will read, one tally and no more; at the distance of one small measure (or one chain) from this point, a 1 tally and 1 chain will be marked down (11) and the expression will read one tally, and one chain more; and so on to the second tally, which will be made and recorded by a 2 and a 0, to the right (20), which will read two tallys and no more. At the distance of one small measure or unit from this place there will be recorded 2 tallys and 1 chain more, or 21, which will read two tallys and one chain; at the distance of two small measures, the record will be 22, which will read two tallys and two chains, and so on.

This we conceive to be the simple structure and probable origin of the Indian method. In its structure it is strictly *geometrical*, using that term in its primitive signification.

It will at once be perceived that the tally is not necessarily made at one small measure beyond 9, but that it may be made at any measure before or beyond that place; but in each case the point of repetition will always be expressed by 10, and this from the fact that it necessarily reads one principal or large measure and no more. This verifies the statement before made that *r*, in Barlow's formula, will always be expressed by 10, and that its appearing as a power is accidental. The whole subject will be clearly exhibited by the following Table:

0	1	2	3	4	5	6	7	8	9	θ	φ
10	11	12	13	14	15	16	17	18	19	1θ	1φ
20	21	22	23	24	25	26	27	28	29	2θ	2φ
30	31	32	33	34	35	36	37	38	39	3θ	3φ
40	41	42	43	44	45	46	47	48	49	4θ	4φ
50	51	52	53	54	55	56	57	58	59	5θ	5φ
60	61	62	63	64	65	66	67	68	69	6θ	6φ
70	71	72	73	74	75	76	77	78	79	7θ	7φ
80	81	82	83	84	85	86	87	88	89	8θ	8φ
90	91	92	93	94	95	96	97	98	99	9θ	9φ
θ0	θ1	θ2	θ3	θ4	θ5	θ6	θ7	θ8	θ9	θθ	θφ
φ0	φ1	φ2	φ3	φ4	φ5	φ6	φ7	φ8	φ9	φθ	φφ

It will here be seen that the repetitions do not necessarily begin at one measure beyond 9 but may begin at any measure before or after that point. It will also be seen how 10 obtains its significance.

The Grecian Method, was also a method of large and small measures, but it had no 0 (zero), 1 (a unit) being the first figure in the scheme, whence, it evidently had its origin in the consideration of individual objects and not in the measure of distances, i. e. it is *arithmetical*, using that term also in its primitive sense. It employs the letters of the Greek alphabet for its characters, the first letter representing a unit, the second letter two units, &c., to ten, which is expressed by ι (iota), the tenth letter of the alphabet; with this character the repetitions begin. A new character is introduced at each repetition, as at twenty, thirty, and so on to one hundred, to represent which a new character is added, when the whole is repeated; new characters are added for each hundred afterwards, to one thousand, which is also represented by a new character, as well as ten thousand, and one hundred thousand, &c. The scheme seems then to be simply this: one, ten and one,—twenty, twenty and one,—one hundred, one hundred and one,—one thousand, one thousand and one, &c. It is seen, contrary to what has been stated, that any number could be expressed by this method, all that was necessary being to introduce a new character at the end of the proper repetition. If the Greeks did not express any number beyond 100,000,000, it was because they either did not understand the scheme of their notation, or because at this point it became unwieldy; the latter was probably the case. It will be also seen that the repetition can commence and be carried on with any number whatever.

The Roman Method, is rather a method of fives than of tens. It begins its repetitions with five, introducing a new character to express that number. It introduces new characters to express ten, fifty, one hundred, five hundred, one thousand, in each case making use of the previous figures in connection with the new ones to express the numbers beyond them. Thus:

I,	II,	III,	IIII,	V,	
VI,	VII,	VIII,	VIIII,	X,	
XI,	XII,	XIII,	XIIII,	XV,	
XVI,	XVII,	XVIII,	XVIIII,	XX,	
XXV,	XXX,	XXXX,	L, C,	D,	M,

which evidently reads, five, five and one, ten, or two fives—for so do some at least explain the figures—two fives and one, three fives, three fives and one, four fives, four fives and one, &c., fifty, fifty and one, one hundred, one hundred and one, five hundred, five hundred and one, one thousand, one thousand and one, &c. It is also evident that it had its origin in contemplating and recording individual objects like the Grecian method, as like it, it is destitute of 0, and consequently its *origin** is a number and not a point.

In comparing these three methods, especially the last two with the first, it is manifest that they had an essentially different source. It is equally certain that the Indian method could not have originated with the Chaldeans, who numbered their flocks and herds and counted the stars, in which operation the unit would hold the first place in their notation; from which circumstance it is not improbable that the Grecian or Roman method came from them, or perhaps from the Phenicians, from whom came also their alphabets. But it is certain that we must look to some different part of the globe to find the makers of the Indian method, to some Egyptian people, to some land measurers, like the dwellers on the Nile,—who indeed may have been the very ones. In an ethnological point of view, if in no other, these circumstances may be of importance, for numbers, like some word of a language, may hold in their secret embrace some untold history of man.

As a result of employing different measures, as circumstances require, in numerical expressions, it will be found that any vulgar fraction can be made to assume the integral, or decimal form, a circumstance which is often overlooked. Take for instance the problem of finding the one-third of ten, or the dividing ten by three. The well-known result is 3·33333333 &c., without a complete expression being attained; but the difficulty will be obviated by using a measure of three, when ten will assume the form 101 and the three, 10.† When the operation is performed with these expressions, thus, 101 ÷ 10, the result will be as seen, 10·1, which is a complete expression: but it should be observed that this is not read ten and one-tenth, but three and one-third, just as the same expression in the denary measure is read ten and one-tenth, the advantage gained being that it is a complete expression, by this method. Should all the measures of the Indian method be developed up to twelve, there would be ten additional ways in which the same number of units could be expressed, by which definite results could be obtained. Leibnitz claimed and received the credit of *inventing* the binary measure which would not have been, had he or his cotemporaries fully

* Employing the word in the sense in which it is used in Conic Sections.

† When 3 assumes the form 10, 9 will assume the form 100, and consequently 10, being 1 more than 9, will assume the form 101. Not that it should be considered to contain one hundred and one units, but that in the ternary measure it is the expression for 10. Barlow's Rule for reducing numbers in the denary measure to any other measure is as follows:

Divide the given number and several quotients as expressed in the denary measure, by the proposed measure, and note the remainders; these remainders, read in an inverse order, will express the given number in the proposed measure. Thus change 1810 in the denary measure to the ternary measure: dividing 1810 by 3 gives 603 and 1 remainder; so 603 by 3 gives 201 and 0 remainder; 201 by 3, 67 and 0 remainder; and so on. The several remainders afford for the result 2111001, for the ternary measure.

understood the Indian method, according to which it was developed. Hutton observes that he had seen a book printed in Germany in which rules for operating with each measure to twelve was given, but does not intimate that he or the author regarded it as a development of the several measures of one scheme, but seems to consider it, as mathematicians in general appear to do, as so many independent methods. Could the several schemes, and especially the Indian, be properly developed in all their different measures, the subject of numbers would assume a more general aspect.

Middlebury, Vt., September, 1845.

ART. IX.—*On the Effect of the Pressure of the Atmosphere on the Mean Level of the Ocean;* by Captain Sir JAMES CLARK ROSS, R.N., F.R.S.*

THE author states that, in September, 1848, Her Majesty's ship Enterprise and Investigator having anchored in the harbor of Port Leopold in lat. 74° N. and lon. 91° W., a heavy pack of ice was driven down upon and completely closed the harbor's mouth, thus effectually preventing their egress, and compelling them there to pass the winter of 1848–49. It was during that period that the series of observations here presented to the Royal Society was obtained; and, as the observations were made under peculiarly favorable circumstances, the author considers they will throw some light on the movements of the tides, and on some of the causes of their apparent irregularities.

Soon after the harbor had been completely frozen over, a very heavy pressure from the main pack forced the newly-formed sheet of ice, which covered the bay, far up towards its head, carrying the ships with it into such shallow water that at low spring-tides their keels sometimes rested on the ground. Under these circumstances the movements of the tides became to the author an object of great anxiety, and consequently of careful observation, in order to ascertain the amount of irregularities to which they were liable in that particular locality.

The first few days' observations evinced much larger differences in the elevation or depression of successive high or low-waters than could be accounted for by any of the generally received causes of disturbance; and the author was at once led to connect them with changes of the pressure of the atmosphere, from perceiving that on the days of great atmospheric pressure high-water was not so high as it ought to have been, and low-water was lower than its proper height; and that the reverse took place on the days of smaller pressure.

* Proc. Roy. Soc. Lond., June, 1854; Lond., Edin. and Dub. Phil. Mag., Oct. 1854, p. 318.

As it was found that the usual method of determining the mean level of the sea, by taking the mean of successive high- and low-waters, was inadequate to the detection of small quantities arising from a change in the pressure, a system of observation was adopted different from that heretofore practised, in order to determine the mean level of the sea on each day.

In the first instance, simultaneous observations of the height of the tide and of the mercury in the barometer were made every quarter of an hour throughout the twenty-four hours. From these it was found that the mean level of the sea for each day could be determined with great accuracy, and that the variation in the daily mean level and in the mean pressure of the atmosphere followed each other in a remarkable manner, so that a rise in the former corresponded to a diminution in the latter. Subsequently, however, hourly observations were adopted.

The peculiar advantages of the position of the ships at Port Leopold for making tidal observations are stated to have consisted in :—

1. The great width of the entrance of the harbor admitting the free ingress and egress of the water, combined with the large field of ice which covered the whole of the bay, completely subduing every undulation of the water.

2. The steady movement of the immense platform of ice, rising and falling with such singular regularity and precision as to admit the reading off the marks of the tide-pole with the greatest exactness, even to the tenth of an inch.

3. The shallowness of the water and the evenness and solidity of the clay bottom admitting the fixture of the tide-pole with immovable firmness.

4. The whole surface of the sea in the neighborhood being, for the greater part of the time, covered by a sheet of ice, preventing those irregularities which occur in other localities from the violence of the wind raising or depressing the sea in as many different degrees as it varied in strength or duration.

For fixing the tide-pole for the "Enterprise" a hole 2 feet square was cut through the icy platform, and a strong pole, nearly 40 feet long, was passed through it and driven firmly down several feet into the clay, being fixed by heavy iron weights, which also rested on the clay and prevented any movement of the pole. It was placed in about 21 feet depth of water at the time of mean level of the sea. Another such tide-pole was, in like manner, fixed through a hole in the ice close to the "Investigator," for the sake of reference and comparison.

Hourly observations of the height of the tide and of the barometer were commenced on the 1st of November, and were continued by the officers of each ship throughout the whole of the nine following months to the end of July. After forty-seven days of observation an interruption in one of the series occurred in consequence of the tide-pole of the "Enterprise" having been drawn up the ice, to the under part of which it had become frozen. The amount of displacement of the pole was easily determined by a comparison with that of the "Investigator," but several days elapsed before it could be satisfactorily fixed at the same point in which it had been originally. The observations of these forty-seven days are those which are given in the paper, and their discussion is the immediate object of the communication.

It is stated that subsequent observations seem to show that, from the time of the interruption to the middle of July, there was a progressive elevation of the mean level of the sea, which although of small amount, was sufficiently evident from month to month to render the subdivision of the series desirable, in order that the individual observations of each separate division should be strictly comparable.

The height of the sea and the corresponding height of the mercury in the barometer, at every hour in each day, from the 1st November to the 18th December 1848 are given in tables. In these the arithmetic mean of the hourly heights of the sea for each day is taken as the mean level of the sea for that day, and the mean of the hourly heights of the barometer is taken as the corresponding height of the barometer. These mean levels and corresponding mean barometric heights are given in another two-column table, arranged in the order of the days of observation; and in a third table these are arranged in the order of the heights of the barometer with the corresponding mean levels, without regard to the dates of observation, for the purpose of showing the dependence which the latter have on the former.

On these tables the author makes the following remarks. The forty-seven days of hourly observations give for the mean height of the baromerer 29·874 inches, and of the mark of the mean level of the sea 21 feet 0·21 in.

The mean of three days *greatest* pressure was	30·227, and of corresponding level	20 feet 8·4 inch.
The mean of three days *least* pressure was ...	29·559, and of corresponding level	21 feet 5·4 inch.
	Diff. +0·668	Diff. −9·0

Thus a difference of pressure equal to 0·668 inch produced a difference of 9 inches in the mean level of the sea. As the ratio of 9 to ·668 is 13·467 to 1, the author considers that the effect of the pressure of the atmosphere on the level of the sea is 13·467 times as great as the effect it produces on the mercury in the barometer, or very nearly in the inverse ratio of the specific gravities of sea-water and mercury. He however states that this remarkable coincidence must be considered in a great measure accidental, for if a greater number of days' observation be taken in order to deduce the mean greatest and mean least pressure, and the corresponding mean levels, a different result will be obtained. From these observations however he considers that he has been enabled to deduce results which plainly point to the law which governs the effect of the pressure of the atmosphere on the mean level of the sea, and may be encouraged to pursue the investigation through a more extended series of observations. in order to arrive at the most accurate conclusion that the observed facts may justify.

In conclusion a formula is given for determining the correct height of the tide, or of the mean level of the sea:—

Let L denote the correct height of the tide, or of the mean level of the sea;
B the mean pressure of the atmosphere;
λ the observed height of the tide, or of the mean level of the sea;
β the corresponding height of the barometer;
D the ratio of the specific gravity of mercury to that of sea-water:

then $L=\lambda+(\beta-B)D$.

Examples are given of the application of this formula.

Art. X.—*Report to the Academy of Sciences, Paris, on the Researches relative to Earthquakes of M. Alexis Perrey;* by the Commission, MM. Liouville, Lamé, and Elie de Beaumont reporter.*

The Academy has charged us, MM. Liouville, Lamé and myself, with reporting on a memoir presented March 21, 1853, by M. Alexis Perrey, Professor in the Faculty of Sciences of Dijon, *On the relations which may exist between the frequency of Earthquakes and the age of the moon*, and on a Note presented the 2d of January, *On the frequency of Earthquakes relatively to the times of the moon's passing the meridian.*

When the memoir of M. Perrey was presented on the 21st of March, M. Arago was appointed on this commission. The death of our illustrious confrère, which happened soon after, left a vacancy in the Commission; and subsequently to the reading of the Note on the 2d of January, one of our number, M. Lamé, was named for the place.

Arago, whom nothing escaped which bore on the physics of the globe, followed with continued interest the researches of M. Alexis Perrey. The Academy has not forgotten the care with

* From the Comptes Rendus, xxxviii, June 2, 1854.

which he called attention to the Notes on Earthquakes addressed to him of late years by the learned Professor of Dijon, and he has often mentioned at our meetings the relations indicated between the frequency of earthquakes and the age of the moon.

The cause of the interest connected with these relations is easily understood. If, as is now generally supposed, the interior of the earth is in a liquid or pasty state through heat, and if the globe has for its solid part only a crust comparatively very thin, the interior liquid mass must tend to yield like the surface waters to the attractive forces exerted by the sun and moon, and there must be a tendency to expansion in the direction of the radius vectors of these two bodies; but this tendency encounters resistance in the rigidity of the crust, which is the occasion of fractures and shocks. The intensity of this cause varies, like that for the tides of the ocean, with the relative position of the sun and moon, and consequently with the age of the moon: and it should also be noted, that as the ocean's tides rise and fall twice in a lunar day, at periods dependent on the moon's passing the meridian, so in the internal fluid of the globe, there should be two changes in a day, the time varying with the same cause.

Without entering now into more details, it will be easily conceived, that if the mobility of the internal mass of the globe plays a part in the production of earthquakes, there must be some dependance, admitting of study, between the occurrence of an earthquake, and the circumstances which influence the action of the moon on the whole globe or on any place or portion of it, that is, the angular distance with the sun, its actual distance from the earth, and its distance from the meridian of the place, or in other terms, the age of the moon, the time of perihelion, and the hour of the lunar day.

These considerations which have not escaped M. Alexis Perrey, have beyond doubt inspired the idea of the two-fold work which we have been charged to examine; and they have obtained for the views, the interested attention of M. Arago and many other men of science. They have involved on the part of the author the determination of the precise date, and period of the moon, for each earthquake on record and even for each shock of which earthquakes may consist—a work of vast labor; the researches have been now continued for several years and are still in progress. * *

In the memoir of the 21st of March, 1853, on the relations between the frequency of earthquakes and the age of the moon, the author devotes the first chapter to the tabulation and the numerical transformation of the results of observation.

He has conceived four modes of tabulating the facts.

In the first method, followed in his memoir presented to the Academy on the 5th of May, 1847, the author reckons as a day of earthquake each of those on which the earth has been shaken, whether it has happened only in one country or on the same identical or different hours in two or several countries, separated by intervals not participating in the movement. Noting then, after the Connaissance des Temps, to what day of the lunation, each day of earthquake corresponded, he brings together in one column all the days which pertain to the first day of a lunation; in a second, all pertaining to the second day of a lunation, and so on. Thus he forms a table consisting of 30 columns, each column giving the number of days of earthquake corresponding to the successive days of the moon. The numbers vary, and the law of variation is the same in his first table comprising a register of 2735 days of earthquakes between 1801 and 1845, as in his later one embracing 5388 days between 1801 and 1850. In both tables, the number of earthquakes during days near the syzygies is a little larger than in days near the quadratures.

In his second method, the author regards as distinct, the earthquakes in different regions separated by an undisturbed region, and each day of earthquake is counted 1, 2, 3, &c., according as the earthquakes of this day were experienced in 1, 2, 3, &c. separate regions. By this new mode of tabulating, the number 2735 is increased to 3041, and that of 5388 to 6596. The same law is observed in these new tables as in the first set: and similar also is the result obtained by dividing the half century into two quarter centuries.

In the third method of arrangement, M. Perrey takes as a distinct phenomenon each of the shocks of which a single earthquake is composed, and registers it separately. But he has not the documents for completing this work, as the number of shocks often is not stated. The author has contented himself by considering by this method 931 shocks felt in Central America and mostly at Arequipa, as published by M. de Castelnau in the 5th volume of his "Voyage dans les parties Centrales de l'Amerique du Sud." This table, without giving identical results with the preceding, leads to the fundamental relation already mentioned.

Finally, in the fourth method of arrangement, the application of which is difficult and has not yet been made by M. Perrey, the collection of shocks in a country, preceded and followed by a period of tranquillity is regarded as a single phenomenon.

To the nine tables formed by one or the other of the first three methods of tabulating, the author has added a tenth, formed by the first mode: it embraces four years, from 1841 to 1845, and only 422 days of earthquakes. Although this number is small the numbers lead to the same general conclusion—that is, the greater frequency of earthquakes at the syzygies than at the quadratures.

This general law, although distinctly observable in the series of results, is however obscured by many anomalies. In order to eliminate these anomalies as far as possible, Prof. Perrey divides the 29·531 days of a lunar month into twelfths, sixteenths and eighths, and obtains, by proportional calculations applied to the number of the different tables constructed according to the solar days, the numbers which correspond to each fraction of lunation. In his new tables thus constructed, excepting some minor anomalies, the law above stated is more fully confirmed, that for a half century earthquakes have been more frequent at the syzygies than at the quadratures.

M. Alexis Perrey has also enquired whether a relation exists between the frequency of earthquakes and the distances, at the time, of the moon from the earth. For this purpose he has tabulated according to the different methods of tabulation pointed out, the number of times the earth has been shaken, on the day of the perigee and apogee of the moon, the day before, night before, the following day, and the next following; he has hence ascertained, by the groups of numbers thus formed, the total corresponding to the perigee, and also to the apogee. In order to facilitate a comparison of the results, he has taken the difference of the totals thus obtained and divided by their sum, whence he has found the quotients

$$\frac{1}{16{\cdot}5},\ \frac{1}{23{\cdot}6},\ \frac{1}{23{\cdot}5},\ \frac{1}{24{\cdot}4},\ \frac{1}{29{\cdot}2},\ \frac{1}{18{\cdot}6},\ \frac{1}{21{\cdot}2},\ \frac{1}{10{\cdot}75},$$

which are all, above $\frac{1}{30}$, and the last nearly equals $\frac{1}{10}$. It appears therefore that the unequal attractions of the moon on the earth at its greatest and least distance from the earth, has a sensible influence on the production of earthquakes.

In the Note of Jan. 2, *On the frequency of earthquakes as related to the passage of the moon over the meridian*, the author aims to discover whether the repetition of the shocks of earthquakes during a lunar day, has, like the tides, a relation to the moon's passing the meridian. He has submitted to this investigation, 824 shocks observed at Arequipa, registered by M. Castelnau, after calculating the hour of each, with reference to the moon. He has thus made out a table, which he afterwards divided into 16 equal parts, and then grouped these by twos into 8 parts, using the mean lunar day of 24 hours 50½ minutes. In this way, notwithstanding some large anomalies which cannot fail to be presented in so small a number of cases, the number obtained by each mode of grouping, gave evidence of the existence in the course of the lunar day, of two epochs of maximum number of shocks and two of minimum, the former at the times of the moon's passing the meridian—the superior and inferior—and the latter at intermediate intervals.

M. Alexis Perrey, by discussing the catalogues which he had formed, thus shows by three ways independent of one another, the influence of the course of the moon on the production of earthquakes.

1. That the frequency augments in the syzygies.

2. That the frequency augments in the vicinity of the moon's perigee, and diminishes towards the apogee.

3. That the shocks of earthquakes are more numerous when the moon is near the meridian than when 90 degrees from it.

The tables still present more anomalies, and the author has omitted nothing which should remove them, so as to bring out the law in all its purity.

He at first thought of representing the frequency by diagrams like those for barometrical observation, a process by which the general march of phenomena is perceived amid the anomalies which tend to mask it. We regret that this has not been done, as it speaks at once to the eye. M. Alexis Perrey has endeavored to obtain his results by calculation, and has devoted to this subject the second chapter of his principal memoir, and the second part of his Note of Jan. 2, 1854.

Without attempting to follow the author in these analytical discussions, we simply state here that, in order to represent the results of observation, he employs a formula of interpolation of the form,

$$\varphi = m + \mathrm{A}\sin(t+\alpha) + \mathrm{B}\sin(2t+\beta) + \mathrm{C}\sin(3t+\gamma) + \ldots$$

in which m, A, B, C, &c., are constant coefficients of the same nature with φ; α, β, γ, &c., are constant angles; and t a variable angle dependent on the lunar motion, which is equal to 0 degree for the new moon, 90 degrees for the first quarter, and 180 degrees for full moon, &c. He then adapts the formula by known methods to each of his tables deduced from observation, by determining the constants which it includes.

By means of the formulas thus obtained, the author has been able to form tables corresponding to those made simply from observations in which the law of the phenomena is presented, free from the principal anomalies which tend to conceal it in the first tables. The numbers contained in these new tables have been constructed with care and have led to regular curves in which the law is expressed fully and clearly. All the curves have a marked resemblance, although not wholly similar:—an identity could not be, for the results are only approximative and take a special impress from the groups of numbers which they represent. The resemblance in the curves leads to two principal maxima, corresponding to the syzygies, and two minima for the quadratures; and sustains the general deduction, that for half a century earthquakes have been most frequent at the syzygies.

The Academy will perceive the importance of this conclusion, and may judge at the same time from the preceding, of the care with which the author has pursued the subject, he having brought together for the half century 7000 observations. This number is however still small for the solution of a problem of this kind, and it is important to increase it both by adding the facts of successive years, and also by going back to past centuries, which the author has already commenced.* * * *

ART. XI.—*On the Periodical Rise and Fall of the Lakes;* by MAJOR LACHLAN, Montreal.†

FEW countries can boast of objects of more imposing natural grandeur or deeper philosophical interest, than are presented in Canada, in the vast extent and other striking peculiarities of its magnificent inland *fresh water* seas, and their noble connecting rivers and unrivalled cataracts, coupled with the singularly anomalous nature of its climate and seasons compared with European countries in the same parallel of latitude: and an additional geographical interest may be considered as attaching to it, in the magnetic meridian passing through it—the line of "No variation" curving through part of its mediterranean waters.‡

The investigation of the causes and effects of these great physical phenomena might well engage the attention of a whole life of patient observation and study; and such, doubtless, will at no distant day, be the case; but in the present state of things, in so young a country, all that can be expected is the occasional contribution of the unpretending philosophical *gleaner;* and, as such, I now venture to lay before the Canadian Institute the following desultory observations on the periodical rise and fall of our great Lakes, in the hope of strengthening the arguments adduced by me in the paper which I had lately the honor of submitting to it, in advocacy of the establishment of a system of simultaneous meteorological and tidal observations throughout British America—as not only a great philosophical desideratum, but also likely to prove of substantial service to the country, were it only to make us better acquainted with the great benefits de-

* This Report closes with a recommendation to the Academy that an appropriation should be made to enable M. Alexis Perrey to complete his valuable researches —especially for books, travelling, and transportation of documents, &c., and in accordance with it a considerable sum was placed at his disposal.

† Read before the Canadian Institute, March 18th, 1854; Canadian Journal, July, 1854.

‡ To do justice to the subject treated of in this paper, a good map of British America should be at hand to be refered to, and, above all others, that graphic "Map of the Valley of the St. Lawrence," constructed by T. C. Keefer, Esq., in which the striking connection of the whole system of Lakes is so well portrayed.

rived and derivable from the climatic influence of our mighty inland waters.*

In the introduction to my former paper, I was led to remark that it is now seventeen years since my attention was first attracted to these interesting philosophical subjects, by remarking the great difference in the newspaper reports of the temperature, direction of the winds, and state of the weather in different parts of the Province at the same time, as compared with each other, and by having been in the habit for seven years, at my residence on the banks of Lake Erie, of noticing the constant extraordinary fluctuations in the level of that noble Lake; at times consisting only of slight irregularly recurring oscillations; at others, showing a sudden change of level, apparently caused by the temporary impulse of passing storms; at others, evincing a longer continued state of elevation or depression, in evident accordance with the more enduring influence of winds blowing from the same quarter for days together; and at others, and more especially and unaccountably, of a longer maintained rise of several feet above the usual level, sometimes lasting for a whole season, or even more, as was the case during the memorable years, 1838–39—regarded at the time by some of my neighbors as the traditional seven years' flood.

Being much struck with these singular phenomena, and yet not being sufficiently at leisure, besides feeling myself otherwise disqualified for attempting a scientific investigation of their causes, I naturally felt, nevertheless, a strong desire to ascertain what had been written on the subject, or might be, from time to time, by more able philosophical observers; and I accordingly made a practice of taking notes from all such published works, and other sources of information, as referred to them, as they happened to fall in my way, until I had, in the course of years, accumulated a mass of miscellaneous memoranda—not to call it testimony—on the subject, of so conflicting a character as frequently rather to add to the perplexity than promote the elucidation of the object in view; and the consequence was, that, after vainly attempting to classify and reconcile the information therein contained, regarding the rise and fall of the Lakes generally, and comparing it with my own passing observations and enquiries respecting Lake Erie in particular, I came to the con-

* As a remarkable instance of the *tempering* influence of the proximity of the Lakes, it may here be mentioned, that in the immediate vicinity of Cleveland, the temperature during ten years has in no instance fallen below zero, while at Columbus, Marietta, and Cincinnati, from 120 to 150 miles farther south, it has frequently sunk to 5 deg. and 10 deg. below it; and that in Northern Ohio, generally, the tender vegetation is usually cut down within five days of the 25th of October, whereas the Lake shore remains untouched for two weeks later; and during the winter, when deep snow falls elsewhere, there is comparatively little near the Lake. —American Journal of Science, 2nd Series, vol. xiii, pp. 215 to 219.

clusion that there was still much room for further investigation, as all the Lakes did not appear to be always governed by simultaneous influences;* and therefore, that the only chance of arriving at a correct knowledge of the state of the whole matter, would be the adoption of some such course of long continued meteorological and tidal observations throughout the country, as that which I ventured to propose in my last paper.

Having in that communication enlarged principally on the value of a wide-spread series of simultaneous meteorological observations, as the more important branch of the great object in contemplation, I propose to confine myself, on the present occasion, to the no less interesting, though minor, part of the undertaking—aiming at the institution of a simultaneous record of the daily variations in the level of the great Lakes, with the view of throwing light on, and, if possible, deciding, the three following doubtful points: 1st, How far there is any foundation for the traditional report, that there is a septennial rise and fall in the waters of the Lakes, and if so, to what height; and whether such phenomenon takes place in all the Lakes simultaneously or otherwise. 2d, The amount of the better known annual variations in the level of the different Lakes; and how far these changes occur in each at the same time; and whether they are solely due to the annual amount of the rain and snow in the surrounding country, compared with that of the evaporation during the summer months, or to any other cause therewith combined. And 3d, How far the daily or other more frequent oscillations, or irregular tides, observable in the different Lakes, are general, and arise from the temporary force and direction of winds passing over their surface, or are peculiar only to certain localities; and whether they are in any sensible degree influenced by atmospheric pressure, or lunar attraction, or otherwise. All which, it is hoped, would in the course of time be satisfactorily decided, by a daily record of the actual level of the Lakes, combined with that of the prevailing winds and weather, at a fixed number of stations, at hours simultaneous with the other meteorological observations.

Taking it, at all events, for granted that such will be the case, I proceed, as an indispensable preliminary step, to take a discursive view of a yet debateable state of the question, as brought home to my mind by a comparison of the casual observations made by myself on Lake Erie, compared with the recorded opinions expressed by others, possessing either greater ability, or more leisure and better opportunities, for prosecuting such an enquiry,—as far as the very miscellaneous and disjointed memoranda accumulated by me will enable me to do so.

* This will be found patiently illustrated in a tabular view of the Rise and Fall of Lake Erie, incorporated in this paper.

In accordance with this intention I may, in the first place, remark, that though the phenomena connected with the various periodical fluctuations in the level of the lakes appear to have attracted the notice of philosophic travellers near two centuries ago, they remained altogether uninvestigated till very lately. The minor tides or oscillations were first alluded to by Fra Marquette, the Jesuit, in 1673, and more particularly by the Baron La Hontan in 1689: and they were afterwards further noticed by Charlevois in 1721, and also by the British travellers, Mr. Carver in 1766, and Mr. Weld in 1796; but it was not till twenty years afterwards that the whole subject began to engage the particular attention of men of science in America, and especially of the talented individuals engaged in the Geological Surveys of the States of New York, Ohio, and Michigan: in this period, I find them successively noticed by Col. Whiting in 1819 and 1829, Mr. Schoolcraft in 1820, General Dearborn in 1826, and Governor Cass in 1828; and more particularly by Professors Hall and Mather, Colonel Whittlesey, Dr. Houghton, Mr. Higgins, and others, in their valuable official reports, from 1838 to 1842; as well as by various observant British officers and travellers, such as Captains Bayfield and Bonnycastle, and Messrs. McTaggart, Macgreggor, and others, the purport of all of whose observations will be found more or less glanced at in the sequel:—and yet, strange to say, these singular phenomena still remain involved in mystery!

It so happens that the observations of all the early writers on this interesting subject were confined to Lakes Superior, Michigan and Erie, and were directed more to the daily fluctuations or tides remarked at particular places, than to the actual existence of the traditionary great septennial rise and fall of the waters of the whole Lakes. Thus, for instance, Baron La Hontan, on reaching Green Bay, at the northern extremity of Lake Michigan, at its conjunction with Lake Huron, remarks that where the Fox river is discharged into that Bay, he observed the waters of the Lake swell three feet high in the course of twenty-four hours, and decrease as much in the same length of time. And he also noticed a contrariety and conflict of currents in the narrow strait which connects Lake Huron and Michigan, which were so strong that they sometimes sucked in the fishing nets, although two or three leagues off. In some seasons it also happens that the current runs three days eastward, two days westward, and one day to the south, and four days to the northward, sometimes more and sometimes less.

Charlevois also noticed similar appearances; and supposes Lakes Huron and Michigan to be alternately discharged into each other through the Straits of Michilimackinac; and mentions the fact that in passing that Strait his canoe was carried by the current against a head wind.

But it was not till fifty years afterwards that we were indebted to that intelligent British traveller, Mr. Carver, for any great additional light on this mysterious subject, as well as for other particulars regarding the then unknown region of Lake Superior, from information acquired on the spot. But as his remarks are alluded to by a subsequent equally respectable and observant English writer, Mr. Weld, who visited Canada in 1796, we are content to refer to the interesting volume of the latter for the following (much condensed) appropriate observations.*

" It is confidently asserted, not only by the Indians, but also by great numbers of the white people who live on the shores of Lake Ontario, that the waters of this Lake rise and fall alternately every seventh year. Others, on the contrary, deny that such a fluctuation does take place; and, indeed it differs so materially from any that have been observed in large bodies of water in other parts of the globe, that I am tempted to believe it is merely an imaginary change. Nevertheless when it is considered, that, according to the belief of the oldest inhabitants of the country, such a periodical ebbing and flowing takes place, and that it has never been clearly proved to the contrary, we are bound to suspend our opinions on the subject. For instance: a gentleman who resides close upon the borders of the Lake, not far from Kingston, and had leisure to attend to such subjects, told me that he had observed the state of the Lake for nearly fourteen years, and that he was of opinion that the waters did not ebb and flow periodically; yet he acknowledged the very remarkable fact that several of the oldest white inhabitants in his neighborhood declared, previous to the late rising of the Lake, that the year 1795 would be the high year; and that in the summer of that year the Lake actually did rise to a very uncommon height. He said, however, that he had reason to think

* I take the opportunity of here remarking that I might easily have imparted a seeming greater degree of originality to this paper by continuing to make only occasional reference to parts of information derived from different writers, and connecting them with a few second-hand observations in my own language; but feeling myself already dissatisfied on that head, and being desirous of exhibiting the whole evidence on the question, independent of any opinion of my own, I have adopted a more equitable course, in allowing as much as possible, my authorities to speak for themselves, in their own language. I may at the same time add, that, in perusing the following and other hurriedly copied extracts and memoranda, accumulated at uncertain intervals during a course of more than fifteen years, and frequently at times when opportunities of access to books were "like angels' visits, few and far between," it must be borne in mind that they were made without any view to publication, and simply for the purpose of furnishing the means of hereafter comparing the observations of different writers on an important philosophical question in which I had long taken a deep interest; and that they will, therefore, perhaps often be found neither altogether verbatim nor regularly connected, and perhaps even betraying not a few verbal errors; but whatever their defects may be, compared with the originals, the reader may be assured that there was no intention to alter or distort the meaning or merits of the author, and that they may therefore be considered as a faithful epitome of more extended observations.

that the rise on this occasion was wholly owing to fortuitous circumstances, and not to any regular established law of nature; and that its being greater than usual was more imaginary than real; and he formed this opinion from the circumstance that when the Lake had risen to its unusual height in 1795, he had questioned some of the oldest people as to the comparative height of the water on this and former occasions, when they affirmed that they had seen it equally high before." Now, a grove of trees which immediately adjoined this gentleman's garden, of at least thirty years' growth, was entirely destroyed this year by the waters that flowed amongst them; and if, therefore, the Lake had ever risen so high before, this grove would have been then destroyed; a circumstance militating strongly against the evidence as to the height of the waters, but which only proved that they had risen on this occasion higher than they had done for thirty years' preceding, and *not* that they had not during that term risen *periodically* above their usual level.*

What Mr. Carver relates concerning this subject rather tends to confirm the opinion that the waters of the Lake do rise periodically. "I had like to have omitted (he says) a very extraordinary circumstance relative to these Straits (of Michilimackinac, between Lakes Michigan and Huron). According to observations made by the French, whilst they were in possession of the fort there, although there is no diurnal flood or ebb to be perceived in these waters, yet from an exact attention to their state a periodical alteration has been discovered. It was observed that they arose by gradual but almost imperceptible degrees till they had reached the height of three feet. This was accomplished in seven and a half years; and in the same space of time they as gently decreased, till they had reached their former situation. So that in fifteen years they had completed their inexplicable revolution. At the time I was there, the truth of these observations could not be confirmed by the English, as they had then been only a few years in possession of the fort, but they all agreed that some alteration in the limits of the Straits was apparent." "It is to be lamented (added Mr. Weld judiciously) that succeeding years have not thrown more light on this subject. . . . A long series of observations are neccessary to determine positively whether the waters of the Lakes do or do not rise and fall periodically. It is well known, for instance, that in wet seasons they rise much above the ordinary level, and that in very dry seasons they sink considerably below it; a close attention, therefore, ought to be paid to the quantity of rain that falls, and to evaporation; and it ought to be ascertained in what degree the height of the Lake is

* The destruction of these trees would depend more on the length of time they were inundated, than on the mere fact of their having been temporarily flooded. —R. L.

altered thereby, otherwise, if it happens to be higher or lower than usual on the seventh year, it would be impossible to say with accuracy whether it were owing to the state of the weather, or to certain laws of nature, that we are as yet unacquainted with. At the same time great attention ought to be paid to the state of the winds, as well in respect to their direction as to their velocity—for the height of the water in all the Lakes is materially affected thereby. Moreover, these observations ought not to be made at one place only, but at different places at the same time. . . .

"It is also believed by many persons that the waters of Lake Ontario not only rise and fall periodically every seventh year, but that they are likewise influenced by a tide which ebbs and flows frequently in the course of twenty-four hours—as, for instance, in the Bay of Quinté, where it has been observed to rise fourteen inches every four hours. But there can be no doubt that this must be caused by the wind—no such regular fluctuation being observed at Kingston, and this Bay being a long crooked inlet, that grows narrower at the upper end; and therefore not only a change of wind up and down would make a difference at the upper extremity, but the waters, being concentrated there, would be seen to rise or fall, if impelled even in the same direction, whether up or down, more or less forcibly at one part of the day than another. . . An appearence like a tide must therefore be seen almost constantly at the head of this Bay, whenever there is a breeze. I could not learn that the fluctuation had ever been observed during a perfect calm; were the waters, however, influenced by a regular tide, during a calm, that would be most readily seen."

Reserving any comments on the foregoing pertinent extracts for a future page, I proceed to remark, that such continued to be the unsatisfactory amount of information on this interesting debatable philosophical question, till about 1819, when Capt. (afterwards Col.) Whiting, of the American army, at length recurring to the exciting subject, made, at the request of Governor Cass, a series of regular observations upon these oceanic appearances, during seven or eight days, in the month of June, serving to show that at that remarkable inlet, Green Bay, there is a daily rise and fall, but that it is irregular as to the precise period or flux and reflux, and also as to the height which it attains;* and yet such was the variety of opinion among local residents on the fact, that he is compelled to state, in the course of his remarks, that being led to suppose that the winter would be the most favorable time for making such observations, when the superincumbent ice would nearly destroy the influence of the winds, and show the unassisted operation of the tide, he made enquiries as to its appearance during that season, when one gentleman informed him

* See American Journal of Science, vol xvi, pp. 90 and 91.

that *no* tide was then discernible, while another, equally intelligent, assured him that it was *very apparent*, and that there was a regular elevation and depression of the ice!

From all which conflicting circumstances (as correctly observed by, I think, Mr. Schoolcraft in the same article) there was reason to conclude that a well-conducted series of experiments would prove that there are *no* regular tides in the Lakes; at least, that they do not ebb and flow twice in twenty-four hours, like those of the ocean; that the oscillating motion of the waters is therefore not attributable to planetary attraction; and that it is very variable as to the periods of its flux and reflux, depending upon the levels of the several Lakes, their length, depth, direction, and conformation, upon the prevalent winds and temperature, and upon other extraneous causes, which are in some measure variable in their nature, and unsteady in their operation.

Colonel Whiting further remarks in another interesting article on the supposed tides and periodical rise and fall of the North American Lakes,* in which is given a table of observations kept at Green Bay, in six weeks, July and August, 1828, that an examination of that record would satisfy any one that planetary influence had little or nothing to do with the changes of elevation in the waters there noted; and that it was as certain that the fluctuations in some places appear to be independent of atmospheric as of lunar control; as, by consulting that table, there would probably not be found one instance where the time of high water tallies with the moon's southing, admitting the usual retardation. And further, that it would also be seen that the changes of elevation were independent of the course of the wind; for that the fluctuation continues, notwithstanding the winds remaining the same. He, therefore, came to the conclusion that, reasoning from our knowledge of the great inland waters of the other hemisphere, we should take it for granted that the North American Lakes have no sensible tides; the Caspian, Black, and Baltic Seas being said to have none worthy of observation, and even the Mediterranean being indebted to the sharp-sightedness of modern times for the knowledge of there being such a phenomenon on her wide spread bosom.† Col. Whiting, however, subsequently remarks, writing in 1830, with regard to what General Dearborn terms "the periodical increase of the whole volume of waters in the American Lakes," that it is the popular tradition on these Lakes that there has been a rise and fall once in every fourteen years, or that its recurrence has been sufficiently precise to authorise the belief in its regularity; but that the New York Canal Commissioners state the intervals to be once in about eleven years; and that no actual observations appeared to have been

* See American Journal of Science, vol, xx, pp. 205 to 219.

† See close of this article.—R. L.

made on the progress of the elevation, as to whether there were any preceding seasons of a character to produce it; and, therefore, after noticing various well-known periods at which remarkable elevations and depressions took place, such as in 1800, 1815, 1820, 1828, and 1830, by way of proof of the periodical return of that phenomenon being regular or otherwise, he was obliged to come to the conclusion that, as far as *facts* go they are certainly in favor of the popular theory, but that it rests on these facts alone, and is in many other points of view improbable and absurd; and that we are therefore constrained to suppose, though destitute of the light of actual observation, that the fluctuations observed must have been caused by unusually abundant rains and snow, and that this abundance had been in fortuitous coincidence with certain *cycles* of time; for, improbable as this may be, it is less so than that nature should have departed from her ordinary course.*

Having, in a previous page, quoted largely from Mr. Weld, I now proceed to notice the judicious remarks on the rise and fall of the Lakes by another intelligent British observer, Mr. McTaggart, who, writing in 1828, sets out by at once *affirming* that "there are no tides in any of the Lakes—none, at least, from the moon's influence; but that the floods of spring generally raise them from three to four feet. It is stated that Lake Ontario rises once in every seven years higher than usual by two feet. The people ascribe this to some supernatural cause. In the spring of 1827 it had one of these periodical tides rising nearly three feet higher than it had done in the previous year, and keeping high the whole summer. Being in the neighborhood (observes Mr. McT.) I paid the utmost attention to the phenomenon, and found that there fell during that summer much more rain than had fallen for many years before; and that there was little sunshine throughout the season; and I, consequently, concluded that the exhalations from the Lake were not so copious. There was another circumstance that puzzled me. Lake Ontario, and indeed, all the Lakes were up to their very highest surface marks, *but the rivers flowing out of them were not.* Those surface marks were very obvious on the rocky shores of the Lakes, drawn like so many chalk lines by Nature herself.

"Rivers do not rise exactly from the same cause as Lakes. If in spring the snow melts off the country on a sudden, and the frozen swamps break up and disembogue their contents, then the rivers will rise to their utmost height as water pours into them on all sides; but when the sun has effected this, they begin to fall. Lakes swell, it is true, from the same cause, but not with the same comparative haste; their surface being of great extent, the floods can only spread over them by slow degrees; and if the sky keep

* See American Journal of Science, vol. xx, pp. 218, 219.

cloudy and the weather moist, so that little evaporation goes on, the surface of the Lake will continue to swell, while that of the river will fall—as the country on either side is drained—nothing tending to keep up its flood but the mere discharge from the Lake. Rivers and Lakes are never at their utmost pitch of flood at the same time; neither are they ever at the lowest ebb at the same time; for when the floods of a river have subsided to a certain extent, the intense heat of the summer sun, setting upon the shelving sides of the rocky channels, and even upon the bed of the river itself, tends greatly to promote the absorption of the waters, whereas in the deep wide Lake this action cannot take place.

"The unusual rise of the waters of the Lakes in some seasons, which some observers state to be seven feet above the common level, seems to be only rationally accounted for by the absence of evaporation, and greater quantities of rain than generally prevail. Once in every seven years it is said to rise thus; but 7, like 3, is a number open to superstition,* not to be always relied on, and it would not be surprising if this flow were to happen once in six, or even in ten years. It will yet, likely, be discovered that when Lake Erie has its brim flood, the others have theirs also during the same season; and when powerful suns are excluded from drinking them up, by the intervention of drizzling clouds, and this exclusion extending over an immense surface, we shall cease to marvel at these wonderful septennial floods. It has also been remarked that the winters after these seasons have had little snow; but *meteorology on this score remains to be further prosecuted, ere the theory dare be advanced, that it is from the moisture absorbed in circumjacent regions* during summer that the snows of winter are supplied."

Passing from the borders of Lake Ontario to the regions of Lake Superior, I am next enabled to refer to some equally peremptory observations on the same subject, made by that eminent British hydrographer and geologist, Capt. Bayfield, on the spot, in the course of 1825–26; from whose valuable and interesting paper on the geology of the latter Lake I extract the following particulars:†

"There is no regularly periodical rising or falling of the Lakes, as has been asserted, whether it be from the influence of the moon, or any other. They rise and fall from accidental causes; such as a very severe winter without the usual thaws. The springs are locked up all winter, and the whole accumulated snow remains until the spring, when the weather, becoming suddenly

* It was stated by Professor Johnston, in his address at the New York Agricultural Society meeting at Syracuse, as a fact, that Holland is exposed on the average of the last thirteen centuries, to one great sea or river flood, every seven years —R. L.

† See Transactions of the Lit. and Hist. of Quebec, vol. i, pp. 1 to 43.

warm, dissolves it at once. Hence it will generally be found that after a very severe winter, the waters of the Lakes will be much higher than at other times. Heavy gales also raise the water in the upper parts of the Lakes, and also cause *currents* in various directions. The rise, however, in Lakes Superior and Huron, from this or any other cause, never exceeds a few feet. . . . Whether a gradual diminution of the waters of Lake superior is now going on, is a point on which no one is qualified to give an opinion; for no observations have been made or recorded to ascertain the interesting fact. Any diminution must be always imperceptibly gradual, and would require constant, accurate, and regularly recorded observations during a great number of years to render this indisputable. The streams which discharge into Lake Superior amount to several hundreds in number, and the quantity of water supplied by them is many times greater than that discharged at the falls of St. Mary, the only outlet. There is, however, no reason to imagine from this that the quantity of water increases; for it is absolutely necessary that there should be a supply very far exceeding the discharge, to replace the immense expenditure arising from the evaporation from so extensive a surface."

Adhering to my intention of reserving for the present any comments on the above, as of other quotations, I now revert to the next American writer on this important subject, namely, General Dearborn, who, in the 16th volume of the American Journal of Science, already referred to, observes that "it is not sufficiently certain that tides may not be produced in the great chain of Lakes, in the same manner as they are in the ocean;" and in proof thereof quotes an elaborate theory of the distinguished Dr. Young (illustrated by three diagrams) which had at that time been sanctioned by the scientific for more than twenty years, not only presuming the possible existence of such tides, but furnishing the means of demonstrating that such is the fact in deep and broad Lakes, and even going so far as, where the area and depth of a lake is known, to give a theorem by which the maximum rise and fall of the waters and the time of its oscillation, or in which a tide wave might pass over it, can be ascertained.* But the General at the same time admits, with regard to "the periodical increase and diminution of the whole volume of water in the Lakes," that he is in possession of no definite facts, save what was contained in a letter from Captain Dearborn, stating, that whilst stationed at the Sault Ste. Marie, on Lake Superior, he had himself observed for three successive days an ebb and flow of one-and-a-half feet, in the course of about two-and-a-half hours each; but that he attributed it to the winds; and that he sup-

* See American Journal of Science, vol. xvi, pp. 78 to 94, and Young's Natural Philosophy, vol. i, p. 578, &c. See also beyond, in this article.

posed that the rise and fall which takes place during periods of from three to seven years, to be possibly the effect of increased depth of water in the Lake, caused by an unusual amount of snow on its borders and tributary streams, or an uncommon rainy season; and that it even appeared from an extract from the *New York Advertiser*, that a gentleman just then (1828) returned from a tour to the West, had informed the editor that the waters of Lakes Ontario and Erie were then nearly a foot higher, while those of Lake Superior were considerably lower than ever known. The General was therefore led to suggest that, to obtain full, and exact data as to the rise and fall of the different Lakes tide-guages should be placed at a number of points on the shore of each, both in their narrowest and broadest dimensions, and the changes carefully observed for a whole year, or at least for several months, and accurate tables kept of the times and extent of each flux and reflux, in which the position, as respects the meridian and the phases of the moon, and also the course of the winds should be noted;—a plan which, it will be perceived, is very similar to that proposed by myself in my late paper on the establishment of simultaneous meteorological observations.

(*To be continued.*)

ART. XII.—*Synopsis of the Ichthyological Fauna of the Pacific slope of North America, chiefly from the collections made by the U. S. Expl. Exped. under the command of Capt. C. Wilkes, with recent Additions and Comparisons with Eastern types;* by L. AGASSIZ.

CYPRINOIDS.

IN order rightly to appreciate the natural relations of the representatives of this family living in the fresh waters of the western slope of this continent, to those found in the waters of its eastern slope and elsewhere, it is important first to reconsider the many genera established by Rafinesque in his "Ichthyologia Ohiensis," as well as those recently added by Messrs. Baird and Girard, and to institute a careful comparison between them and those founded by European ichthyologists; for though it is gratifying to behold the zeal with which important additions are daily making to our fauna by the activity of the scientific members of the various expeditions which have lately explored the western parts of the United States by order of the Central Government, it is deeply to be regretted that no more criticism is displayed in the notices which have been published descriptive of these animals. Instead of careful comparisons with more or less allied foreign forms, we are presented with such descriptions of our fishes and reptiles, as would leave the impression that nothing like them is to be found in any other part of the world.

The family of Cyprinoids presents peculiar difficulties whenever we attempt to characterise its genera, as is too well shown by the conflicting views of those who have written upon this subject.

This difficulty arises chiefly from the uniformity of its representatives, greater than is observed, in most other families, and also from the necessity of resorting to dissections to trace their most important characteristics.

In a paper published in 1834 in the Mémoires de la Société des Sciences Naturelles de Neuchâtel, I have however shown that reliable characters may be obtained from the pharyngeal teeth, and the more recent investigations of Heckel upon this subject have confirmed my statements and extended them over a large number of genera and species unknown to science at the time I published the results of my first investigations. At the time Heckel published his valuable remarks upon Cyprinoids, he seems to have been but scantily provided with American representatives of this family.

It is this gap in our knowledge I intend to fill here in connection with a more full description of the species collected in Oregon and California by the naturalists of the expedition of Capt. Wilkes.

The propriety of establishing new genera among Cyprinidæ will appear very questionable to the ichthyologists who have traced the almost endless divisions to which this family has of late been submitted. Nevertheless I feel compelled to introduce some new divisions among them, to classify several fishes which have been collected by the United States Exploring Expedition, and some others long known from the eastern parts of this continent.

Few Cyprinidæ have as yet been described from the fresh waters of the northwest coast of America, and the species brought home by the Exploring Expedition form an interesting addition to our knowledge.

The first question which arises upon examining these fishes is naturally,—to what genus do they belong? Are they in any way analogous to the Cyprinidæ of the eastern or Atlantic side of North America, or do they resemble those of western Europe, or are they in any way related to the Asiatic types? As soon as I knew that species of that family had been preserved among the collections of the Exploring Expedition, my first care was to examine their generic relations, and, to my utter astonishment I found that they do not belong to any of the numerous genera established by myself, Heckel, Prince Canino, or McLelland for the species of the old world, and that, with one exception, they correspond as little to any of the types which occur in the eastern parts of the North American continent. They constitute in fact by themselves a natural group of species, remarkable for the development of their lips, and the horny covering which protects the outline of the mouth. Their pharyngeal teeth also, as far as I have been able to ascertain, have a peculiar structure. Even if the subdivision of the Cyprinidæ into genera had never been extended beyond the limits marked out by Cuvier, three, at least of the species from Oregon should be admitted as new types of this family, for which genera I shall propose the names of Mylocheilus, Ptychocheilus and Acrocheilus.

TRIBE OF CATOSTOMI.

Heckel subdivides the family of Cyprinoids into ten tribes, the fourth of which embraces our Catostomi. This tribe is very natural, if we exclude from it the genus Exoglossum, the true affinities of which are with Chondrostoma and not with Catostomi as Heckel admits. The true Catostomi have very remarkable pharyngeal bones, with a large number of compressed teeth, arranged like the teeth of a comb, upon the inner prominent edge of these bones, and gradually increasing in size from above downwards, whilst in Exoglossum the teeth are few in number, obliquely truncate and occupying only the middle of the curve of the pharyngeals as in Chondrostoma.

For a long time past I have sought in vain to find out the homology of these curious pharyngeal teeth, so peculiar, and so characteristic in the family of the Cyprinoids. It was not until I began to investigate the various types of the old genus Catostomus, that I found a clue to their true significance. The armature upon the inner curve of the branchial arches of Cyprinoids differs so completely from the common type of their pharyngeal teeth, in the genera of the old world, that even a comparison between them is hardly suggested; but in Catostomus the extensive row of comb-like teeth, upon the posterior edge of the inner margin of the pharyngeal arches is so combined with a row of horny serratures upon the anterior edge of the same margin, that the homology of the two becomes at once obvious. See fig. 2, a' and a''. The pharyngeal teeth correspond to the armature upon the inner curve of the branchial arches; they may, however, be either simple epidermic serratures or papillæ, or assume the structure of genuine teeth and become soldered to the bone upon which they are formed, as is the case also with the maxillary teeth of so many fishes.

Notwithstanding the similarity of the general arrangement of the pharyngeal teeth in all Catostomi, there are still such differences in their form and number, and especially in the shape of their inner edge, that these peculiarities afford additional evidence of the propriety of acknowledging several genera among them, most of which have already been indicated, though very indifferently characterised by Rafinesque. In order to ascertain beyond a question the generic value of these characters I have examined the pharyngeals of every one of the species described in this paper, and of several of them compared a number of specimens of different ages and sexes with one another, and I have invariably found that within the limits within which the genera are circumscribed here, they present a peculiar type for each genus, reproduced in the different species with slight variations in the size and proportions of the teeth, the strength of the arch and the length of its symphysis.

Thus far the whole tribe of Catostomi must be considered as belonging exclusively to North America, the true relations of the Catostomus Tilesii, founded by Valenciennes, upon the description of the Cyprinus rostratus, from Northern Asia, by Tilesins being still doubtful, or wanting at least the only confirmation acceptable in our days, that is based upon a direct comparison of original specimens. Catostomi are found as far south as Texas and along the northern boundaries of Mexico, as is shown by the descriptions of several species published by Messrs. Baird and Girard in the Proceedings of the Academy of Natural Sciences of Philadelphia for 1854, but I have been unable to ascertain whether they inhabit the waters of Cuba.

It is a very interesting fact that while America has no native representation of the tribe of Carps, some of its Catostomi, the Carpiodes, Ichthyobus and Bubalichthys, remind us strongly by their external appearance of the true Cyprini of the old world, whilst others, the Cycleptus and Moxostoma resemble more the Borbus of Europe, Asia and Africa and the Tinca of Europe, which are also entirely wanting in America, and still others, the Catostomi proper have not even analogous representatives in the eastern continents.

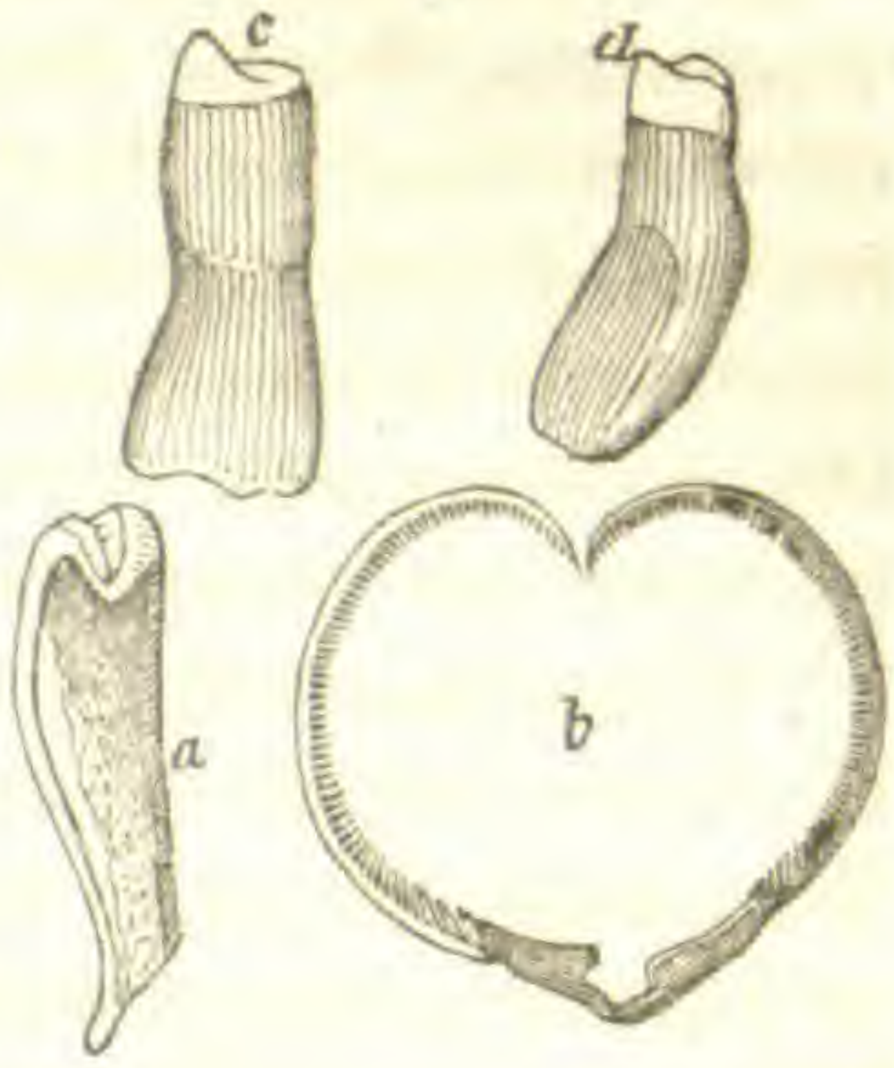
Carpiodes, Raf.

1. The body is very high and strongly compressed, the narrow ridge of the back forming the outline in front of the dorsal is very much arched, and regularly continuous downwards with the rather steep profile of the head.

The head is short, its height and length differ but little. The snout is short and blunt. The small mouth is entirely inferior, and surrounded by narrow thin lips, which are more or less transversely folded. The lower jaw is short and broad.

The pharyngeal bones of Carpiodes are remarkably thin, compressed laterally, with a shallow furrow along the anterior margin on the inside, and another more central one on the outline of the arched surfaces; the teeth are very small, compressed, equally thin along the whole inner edge of the bone, forming a fine comb-like crest of minute serratures; their cutting edge rises above the

1.



inner margin into a prominent point. Fig. 1, *a*, represents the inner surface of the right pharyngeal, *b*, the dental edge of the two pharyngeals in their natural position, *c* and *d*, magnified teeth in profile.

The anterior lobe of the long dorsal is slender, its third and fourth rays being prolonged beyond the following ones into long filaments. The lower fins are all pointed, rather small, and hence distant from one another. The ventral ridge of the body is flat. The scales have many narrow, radiating furrows upon the anterior field, and one, more deeply marked, in a straight line, across the lateral fields, or limiting the lateral and posterior fields, hardly any upon the anterior field, the waving of the broader concentric ridges producing only a radiated appearance upon that field. Tube of the lateral line straight and simple, arising in advance of the centre of radiation, which is seated in the centre of form of the scales.

Cuvier referred erroneously the type of this genus to his genus Labeo, in which he has been followed by DeKay, whilst Valenciennes founded upon it his genus Sclerognathus. Rafinesque however, had already called it Carpiodes; this latter name having the priority, must therefore be retained. Moreover Valenciennes describes as a second species of that genus under the name of Sclerognathus Cyprinella, a fish from Lake Pontchartrain, which belongs to Rafinesque's genus *Ichthyobus*, as I shall show below. In recognising the generic differences which distinguish these two fishes, Rafinesque has really been much in advance of more recent observers, though the characteristics he ascribes to them are very loosely and imperfectly drawn.

I know now four species, of this curious genus, one of which inhabits the fresh waters of our middle States, emptying into the Atlantic, the Catostomus Cyprinus of Lesueur; another occurs in Lake Champlain and the waters of our Northern States, emptying into the St. Lawrence, the Catostomus Cyprinus of the Rev. Zad. Thompson; a third is found in the Ohio, and its tributaries, and has been described under the same name as the preceding ones, by Dr. Kirtland in his "Fishes of the Ohio." I have lately obtained a fourth from the Osage River, through the kindness of Mr. George Stolley, which I have inscribed as *Carpiodes Bison* in my notice of the Fishes of the Tennessee River.* It occurs also in the Mississippi, above its junction with the Missouri, as I have ascertained recently from specimens forwarded to me by Dr. Rauch of Burlington, Iowa; whether it is found farther south, I do not know.

* See this Journal, 2nd Ser., vol. xvii, p. 356.

In my enumeration of the fishes of the southern bend of the Tennessee River, I made a mistake in preserving the name of *C. Cyprinus* for the Ohio species; but having known that species for many years, I took it as the type of the genus the more readily, since Rafinesque has established the genus Carpiodes from Ohio specimens. Yet this species, *C. Cyprinus*, was described by Lesueur from Pennsylvania specimens, so that the name of *C. Cyprinus* belongs to it by right of priority, and the name of *C. Vacca* which I have applied in my notice of the fishes of the Tennessee River to the Pennsylvania species, must be considered as a mere synonym of *Catostomus Cyprinus* of Lesueur, and the Ohio species must retain Rafinesque's name of *Carpiodes velifer.* Lesueur himself had already pointed out in the Journal of the Academy of Natural Sciences, vol. i, p. 110, the differences he noticed between some specimens obtained in the Ohio River, by Mr. Thomas Say, and preserved in the Museum of the Academy of Nat. Sci. in Philadelphia, and those from the Chesapeake Bay he described under the name of *C. Cyprinus.* Upon these indications, Rafinesque founded his *Carpiodes velifer*, Ich. Oh., p. 56, without perceiving that it is identical with his own *Carp. Carpio;* though he had already a few lines higher in the page called it *C. setosus*, referring that name erroneously to Lesueur. Again page 51, Rafinesque describes the same species once more, from a drawing of Mr. Aububon, under the name of *Catostomus anisopterus*, referring it to his subgenus Moxostoma, though he points out himself its true affinity to *C. velifer.* With these materials before me, I was very anxious to obtain also original specimens of the fish described by Rev. Z. Thompson, under the name of C. cyprinus, from Lake Champlain. To that gentleman himself, I am now indebted for the means of comparing it with the species described by Lesueur and Rafinesque, and I find that it is still another species for which I propose the name of *C. Thompsoni.*

These species, though very similar in general outline and compression of body, instantly strike one on comparing them as distinct; the different form and size of scales give to each a very peculiar appearance. In *Carpiodes velifer*, which has the largest scales, their hind border is very broadly arched or rounded, whilst in *Carpiodes Thompsoni*, it forms a very blunt or open angle. Hence in the former species, the posterior margin of a row of scales extending obliquely from the dorsal to the ventral region is strongly waved, but in the latter species it is straight. In Carpiodes velifer the radiating lines on the opercle are more prominent, and the subopercle is longer and not so broadly rounded at its lower angle, and the anterior lobe of the dorsal is higher and much more slender than in Carpiodes Thompsoni. *C. Cyprinus* is more elongated than either, and *C. Bison*, from Osage River, is the most elongated of the four species, and its snout is most prominent. Valenciennes states that *C. Cyprinus* occurs also in Lake Pontchartrain, Louisiana; but this is incorrect. He has mistaken my *C. Taurus*, which belongs to the genus Bubalichthys, for the true Cyprinus of Lesueur. This result shows how important it is in identifying fishes from distinct water basins, not to trust implicitly to descriptions for comparison, but to resort as far as possible to original specimens. I shall have full opportunity below to show also how dangerous it may be to take for granted that because fishes occur in distant regions, they must differ specifically, and to describe them as such.

Whether *Carpiodes tumidus*, B. and G., from Texas, belongs to this or the following genus, or to Ichthyobus, I am unable to ascertain from the description published by Messrs. Baird and Girard in the Proceedings of the Academy of Natural Sciences in Philadelphia, 1854, p. 28.

I am entirely at a loss to understand why Rafinesque should have referred his *Catostomus xanthopus* with C. Cyprinus and Velifer to his subgenus Carpiodes. It certainly does not belong to the same genus as the description shows, in which the dorsal is said to be "hardly falcate with 14 rays," I have scarcely any doubt that Rafinesque had an old specimen of Lesueur's *Catostomus nigricans* before him when he described his *Cat. xanthopus*. Not supposing that species to occur in the Ohio, he did not even compare it with the description of Lesueur; but the name "mud sucker," the specific name xanthopus and the statement that the "head is larger, flattened above," &c., apply together only to Cat. nigricans, which, as Dr. Kirtland has already shown, and as I also know from direct observation, is not only found in the Ohio, but occurs very extensively in our western waters, even as far as Osage River, whence I have obtained specimens through Mr. George Stolley, and also in the middle Atlantic States.

Bubalichthys, Agass.

At the time I vindicated the propriety of restoring some of the genera established by Rafinesque among Cyprinoids,* I did not suspect that the genus Carpiodes as I then represented it, still contained two distinct types, though I had noticed that some of the species had the anterior margin of their dorsal greatly prolonged, whilst in others it hardly rises above the middle and posterior portion of that fin. Having since examined the pharyngeals of all the species of this tribe which I have been able to secure from different parts of the country, I find that those with a high dorsal, which constitute the genus Carpiodes proper, have in addition very thin flat pharyngeals with extremely minute teeth, whilst those with a low dorsal have triangular pharyngeals with

* See this Journal 2nd Ser., vol. xvii, page 353.

larger teeth, increasing gradually in size and thickness from the upper margin of these bones towards their symphysis. The difference in form of these bones arises from the circumstance that the slight ridge upon the outer surface of the arch in Carpiodes is transformed in this second type into a prominent edge, dividing the outer surface of the arch into a posterior and an anterior plane, meeting under an acute angle. This structural homology is satisfactorily traced by the difference in the external appearance of these two planes, the posterior one being full as the posterior half of the flat outer surface of the arch in Carpiodes, whilst the anterior plane is coarsely porous, indeed studded with deep pits analogous to the porous character of the anterior half of the outer surface of that bone in Carpiodes. The teeth themselves are compressed; their grinding edge is rather blunt, slightly arched in the middle, and provided with a little cusp along the inner margin which is hardly detached from the crown and does not rise above its surface, as in Carpiodes, Ichthyobus and Cycleptus.

2.

Fig. 2, *a*, represents the right pharyngeal seen from behind, *a'* being the crest of teeth, *a''* the armature of the anterior edge of the inner curve, *b* one of the lower, *c* one of the middle, and *d* one of the upper teeth.

In this genus the bulk of the body is not placed so far forwards as in Carpiodes, the greatest height being midway between the head and tail. The upper outline of the body is less strongly arched in advance of the dorsal; the head is longer than high, and the snout not more prominent than the mouth. The mouth opens obliquely downwards and forwards, the lower jaw being nearly as long as the upper. The lips are small and granulated. The anterior rays of the dorsal are not separately prolonged beyond the rest of the fin, though its anterior margin is higher than its middle and posterior portion. The lower fins are as in Carpiodes.

The scales have many narrow radiating furrows upon the anterior field, none across the lateral fields, and few upon the posterior field, converging to the centre of radiation to which the tubes of the lateral line extends also. For this new genus I propose the name of Bubalichthys, intending to recall the name of Buffalo fish, commonly applied to its species. To this genus belong the species I have described as *Carpiodus Urus* from the Tennessee River,* *C. Taurus* from Mobile River, and *C. Vitulus*

* See this Journal, 2nd Ser., vol. xvii, p. 355 and 356.

from the Wabash, and also the *Catostomus niger* of Rafinesque and *Catostomus Bubalus* of Dr. Kirtland from the Ohio, but not *Cat. Bubalus*, Rafinesque, which is the type of the genus Ichthyobus described in the following paragraph. I have another new species from the Osage River, sent me by Mr. George Stolley. This shows this type to be widely distributed in our western waters; but thus far it has not been found in the Atlantic States. I have some doubts respecting the nomenclature of these species which are rather difficult to solve. It will be seen upon reference to Rafinesque's Ichthyologia Ohiensis, p. 55 and 56, that he mentions two species of his subgenus Ichthyobus, one of which he calls *C. Bubalus*, and the other *C. niger;* the second he has not seen himself, but describes it on the authority of Mr. Audubon as "entirely similar to the common Buffalo fish, his *C. Bubalus*, but larger, weighing sometimes upwards of fifty pounds." Dr. Kirtland, on the other hand, describes the *C. Bubalus* as the largest species found in the western waters, and adds that the young is nearly elliptical in its outline and is often sold in the market as a distinct species, under the name of *Buffalo Perch.* If there was only one species of Buffalo in those waters the case would be very simple, and the Catostomus Bubalus and niger of Rafinesque, and C. Bubalus of Dr. Kirtland, should simply be considered as synonymous,* but Dr. Rauch of Burlington has sent me fine specimens of this Buffalo Perch, to which the remark of Dr. Kirtland, "elliptical in its outline," perfectly applies, and I find that it not only differs specifically but even generically from the broader, high-backed, common Buffalo, and being the smaller species, I take it to be Rafinesque's C. Bubalus, the type of his genus Ichthyobus, which is more fully characterised below, whilst the larger species, Rafinesque's C. niger, can be no other than Dr. Kirtland's C. Bubalus, "the largest species of the western waters." It seems therefore hardly avoidable to retain the name of C. niger or rather *Bubalichthys niger* for the common Buffalo, though Rafinesque, who first named that fish, never saw it, or if he saw it mistook it for his own Bubalus, and though Dr. Kirtland, who correctly describes and figures it, names it C. Bubalus, for such is the natural result to which the history of the successive steps in our investigation of these fishes lead. But our difficulties here are not yet at an end. Among the splendid collections I have received from Dr. Rauch, I found two perfectly distinct species of *Bubalichthys*, one with a large mouth, and the other with a small mouth, and one of *Ichthyobus*, living together in the Mississippi River, in the neighborhood of Burlington, Iowa, and the next question, probably never to be

* Dr. Kirtland and Dr. Storer, who follows him, are certainly mistaken in referring C. niger of Raf., to Cat. elongatus of Lesueur, as the description in the Ichthyologia Ohiensis clearly shows.

solved, will be, if they all three occur also in the Ohio, whether Rafinesque's C. niger was the big-mouthed or the small-mouthed Bubalichthys. Judging from the figure, given by Dr. Kirtland in the Boston Journal of Natural History, vol. v, pl. 19, fig. 2, I believe his C. Bubalus to be the small-mouthed species. I myself have however only seen one specimen of the big-mouthed species from the Ohio, and that in a rather indifferent state of preservation, for which I am indebted to Prof. Baird, and none of the small-mouthed species. Should however all three, as is possible, occur as well in the Ohio, as in the Mississippi, to avoid introducing new names, I would call the big-mouthed species B. niger, preserving for it Rafinesque's specific name,—the small-mouthed, B. Bubalus, retaining for it the name which Dr. Kirtland has given it, even though the species of Ichthyobus must bear the same specific name, being that originally applied to it by Rafinesque. It may be that either my B. Vitulus or my B. Urus is identical with Dr. Kirtland's C. Bubalus, but until I can obtain original specimens of his species, this point must remain undecided, as it is impossible from mere descriptions to institute a sufficiently minute comparison. The specimen from Osage River, I shall call B. Bonasus.

Compared with one another, these species differ as follows: *B. niger* (the big-mouthed Buffalo) differs from *B. Bubalus*, (the small-mouthed Buffalo) by its larger mouth, opening more forwards, its more elongated body, the first rays of the dorsal rising immediately above the base of the ventrals, and its anterior lobe being broader, and the anal fin not emarginated; *B. Bonasus* differs from B. Bubalus and from B. niger in having the mouth larger than the first and smaller than the second, and from B. Bubalus by its less emarginated dorsal, which renders its larger lobe broader, anal fin not emarginated, opercle larger. A farther comparison with the southern species could only be satisfactory if accompanied by accurate figures.

I therefore turn now to the genus—

Ichthyobus, Rafin.*

In the form and position of the fins, as well as in the general outline of the body, this genus is very nearly related to Bubalichthys, but in the structure of the parts of the head, it is quite dissimilar. The mouth opens directly forwards, and is large and round. The lips are small, smooth and thin; the upper one is not thicker than the intermaxillary itself and tapers to a narrow edge. At the symphysis of the lower jaw, which is larger than in any other genus of this group, the lower lip is hardly more than a thin membrane connecting its small lateral lobes.

* Rafinesque spells the name incorrectly Ictiobus; as its name means Bull or Buffalo fish, from ἰχθὺς and βοῦς it ought to be spelled Ichthyobus, as I have already stated it in my Nomenclature Zoologicus: Index universalis, p. 194.

The eye is small, and the opercular pieces very large.

The scales have many narrow radiating furrows upon the anterior field; none across the lateral fields, few upon the margin of the posterior field and these not extending to the centre of radiation. Tubes of the lateral line straight and simple, arising nearly in the middle of the posterior field.

The pharyngeal bones are neither flat, as in the Carpiodes, nor triangular as in Bubalichthys, but present an intermediate form; the outer surface of the arch standing outwards, and presenting a porous outer margin. The peduncle of the symphysis is much longer proportionally and more pointed than in Carpiodes and Bubalichthys. The teeth are very numerous, small, thin and compressed as in Carpiodes, but the lower ones are gradually larger than the upper ones. Their inner edge is slanting outwards, and not uniformly arched as in Bubalichthys, or truncate as in Cycleptus, the innermost margin rising somewhat in the shape of a projecting cusp.

3.

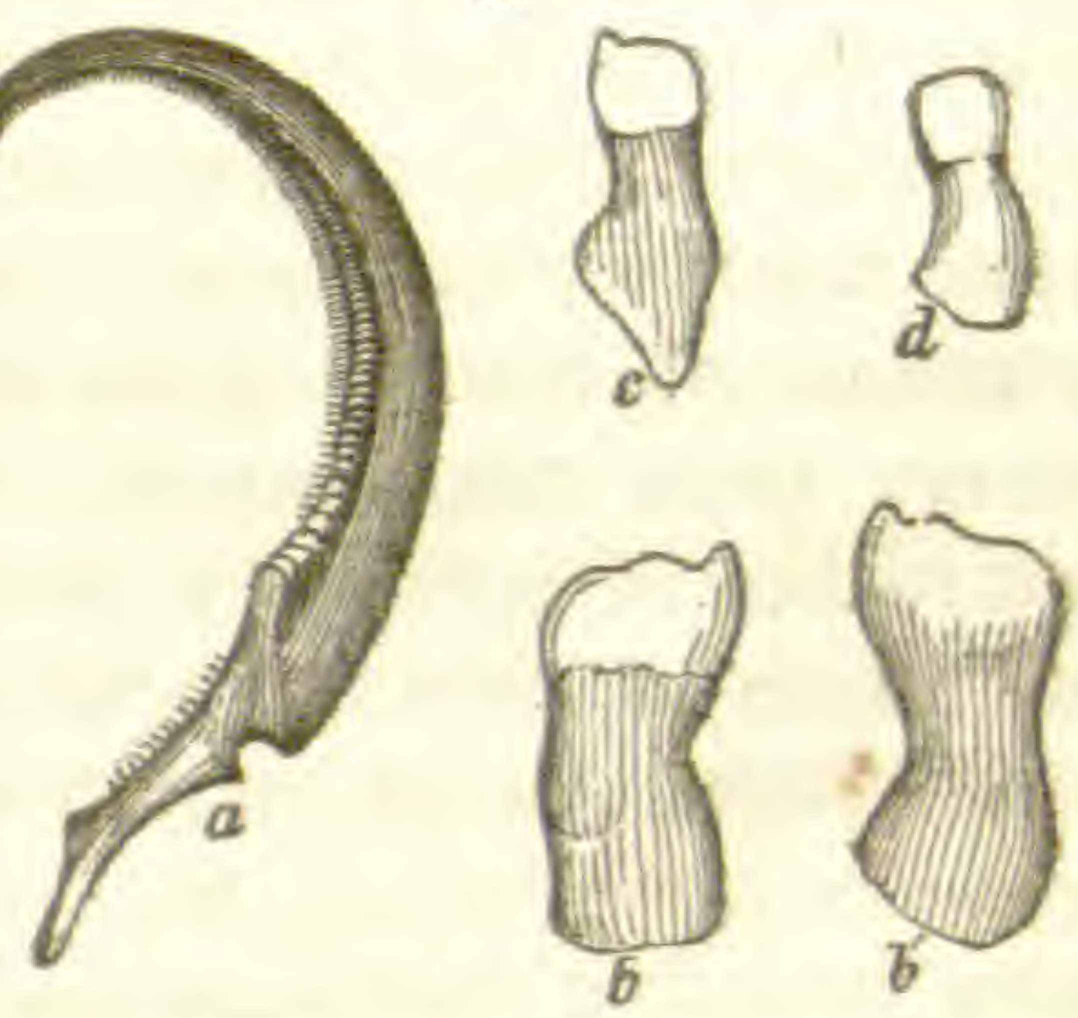


Fig. 3, *a*, represents the right pharyngeal of *Ichthyobus Rauchii*, from the inner side, *b* and *b'* lower teeth from both sides, *c* a tooth from the middle of the comb, and *d*, one from its upper end.

Thus far a single species of this genus has been accurately described by Valenciennes, under the name of *Sclerognathus Cyprinella*, from lake Pontchartrain, near New Orleans; but as I have remarked above, the genus Sclerognathus can not stand, since it includes two distinct types, for both of which Rafinesque has already introduced unobjectionable names. One of these genera is founded upon the Catostomus Cyprinus of Lesueur, and will retain the name of *Carpiodes*, as characterised above, the other is the subject of this paragraph, for which the name of *Ichthyobus* must be preserved, even though its typical species C. Bubalus was so imperfectly described by Rafinesque as to be mistaken by Dr. Kirtland for the common Buffalo of the Ohio, as I have shown above. *Ichthyobus Bubalus*, Raf., is easily distinguished from the two following new species by its low dorsal, its small fins, and high scales.

Ichthyobus Rauchii.—Dorsal much higher than in I. Bubalus, all other fins much larger, and the scales not higher than long; from Burlington, Iowa. Received from Dr. Rauch, to whom I am indebted for a very large collection of fishes from the Mississippi, and its tributaries in the State of Iowa.

Ichthyobus Stolleyi.—Body higher than in Ichthyobus Rauchii, profile steeper, and hence snout blunter, opercular bones larger, fins proportionally of the same size. From Osage River, Missouri.

I have obtained this species from Mr. George Stolley, who has made extensive zoological collections for me in the western and southern parts of the State of Missouri especially along the Osage River and its tributaries.

Cycleptus, Raf.

As in many other instances, Rafinesque has named, but neither defined nor characterised the genus to which I now call attention. He has not himself even seen the fish upon which the genus is founded, and refers to another genus a species which cannot be separated from this. Moreover the characteristics of the genus, as given by Rafinesque are not true to nature. Yet, notwithstanding these objections, I do not feel at liberty to reject his generic name; since it is possible to identify the fish he meant by the vernacular name under which it is known in the West. There is another reason why Rafinesque's descriptions of our western fishes ought to be most carefully considered and every possible effort made to identify his genera and species, the fact that he was the first to investigate the fishes of the Ohio and its tributaries upon a large scale, and that notwithstanding the looseness with which he performed the task and the lamentable inaccuracies of his too short descriptions, his works bear almost upon every page the imprint of his keen perception of the natural affinities of species, and their intimate relations to one another; so much so, that even where he has failed to assign to his genera any characters by which they may be recognized, yet, when the species upon which they are founded can be identified, we usually find that there are good reasons for considering them as forming distinct genera.

The trouble with Rafinesque is, that he too often introduced in his works species which he had not seen himself, and which he referred almost at random among his genera, thus defacing his well characterised groups, or that he went so far as to found genera upon species which he had never seen, overlooking perhaps that he had already described such types under other names.

The genus *Cycleptus* affords a striking example of all these mistakes combined together. In his remarkable paper upon the genus *Catostomus*, Lesueur describes and figures one species from the Ohio River, under the name of *C. elongatus* peculiar for its elongated cylindrical body, and for its long dorsal fin beginning half way between the pectorals and ventrals, and extending as far back as the insertion of the anal. This species Rafinesque introduces in his subgenus *Decactylus* among the genuine Catostomi, without perceiving that it belongs to his own genus *Cycleptus*. This mistake arises undoubtedly from his belief that in Cycleptus there are *two dorsals* which indeed he mentions as characteristic of this genus; but this statement is erroneous: the rays of the dorsal are in fact, enclosed in a continuous membrane, the anterior rays only being much longer than those of the middle and posterior portion of that fin; occasionally these long rays split, and accidentally separate from the following ones, when they seem to form two dorsals.

The character of this genus, as far as the dorsal fin is concerned, consists in reality not in its division, but in its great extension along the back, and the elongation of its anterior rays. The anal is very small in proportion to the size of the fish, and inserted far back, so that the length of the abdominal cavity is greater than in the genera Carpiodes, Ichthyobus and Bubalichthys, with which Cycleptus is closely allied by the peculiar form of its dorsals. Again, Rafinesque remarks that the mouth is terminal, round and small. This requires also to be qualified. The mouth appears terminal and round only when the jaws are protruded to their utmost extent; when closed, it is rather crescent-shaped and entirely retracted under the projecting, pointed snout; the lips are covered with numerous projecting papillæ and spread horizontally.—these are moreover continuous around the angles of the mouth, so that the upper and lower lips are hardly separated by a small fold, and the lower lip is slightly emarginate in the middle, while in other genera of this tribe it is actually bilobed.

The pharyngeal bones are strong, their anterior surface being flattened and their greatest diameter being the transverse one, as in Bubalichthys and not laterally compressed and thin as in Carpiodes and Ichthyobus.

The symphysis is short and its penduncle flat and square, separated from the curved arch by a deep semicircular emargination. The teeth are also stronger and stouter than in Carpiodes and Ichthyobus, as is also the case in Bubalichthys, and they are gradually increasing in size, and relative thickness from the upper part of the arch to its symphysis, but they are much fewer and farther apart than in the latter genus. Their inner edge is transverse, rather blunt, though the middle ridge is somewhat projecting; the lower teeth are so shaped that their inner angle is hardly higher than the outer, while in the middle and upper teeth it is gradually more projecting, and from the middle of the arch upwards forms a prominent point arched outwards.

4.

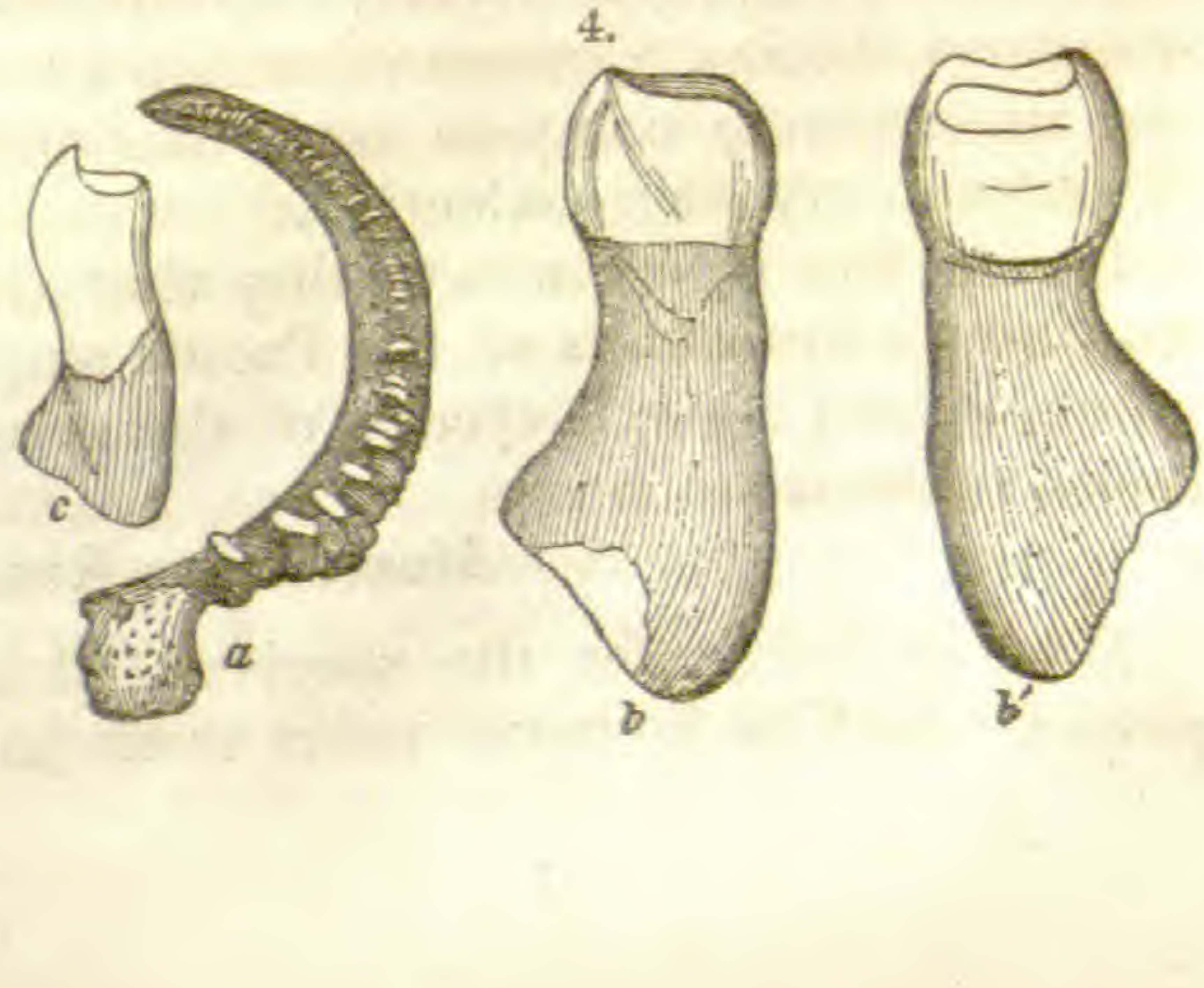


Fig. 4, *a*, represents the right pharyngeal of *Cycleptus nigrescens* from the posterior side, *b* and *b′* being two lateral views of the lower teeth, and *c* a view of an upper tooth.

The scales are considerably longer than high, with a rather prominent posterior margin; numerous radiating furrows upon the anterior and posterior fields, some across the lateral fields; the concentric ridges of the posterior field are not only broader that those of the other fields, but instead of running parallel to the margin of the scales they are curved in concentric gothic arches between each two radiating furrows. Heckel mentions this genus under the name of Rhytidostomus, but Rafinesque's name Cycleptus has the priority. Properly it ought to be called Leptocyclus, according to its etymology, (see my Nomenclator Zoologicus: Index Universalis, p. 109,) but under this form nobody would recognize it as Rafinesque's name, I shall therefore not urge the change. I must leave it doubtful whether we have more than one species of this interesting genus. I have before me specimens from Cincinnati, kindly forwarded to me by Prof. Baird, and others from St. Louis, Missouri, for which I am inindebted to Dr. George Engelmann, but they differ so much in size, those from Ohio being young and those from Mississippi rather large, that I am unable to decide whether the differences they exhibit are specific or merely characteristic of their age. In the St. Louis specimens the peduncle of the tail is shorter, the lobes of the caudal fin broader, the scales of the sides of the body less pointed behind and the caudal fin not so deeply forked. Should these differences prove specific, the name of *Cycl. nigrescens* proposed by Rafinesque may be retained for the St. Louis type, and that of *C. elongatus* for that of Cincinnati; should they be the same, the name *elongatus*, applied by Lesueur for his Catostomus elongatus, having the priority over that of Rafinesque, must be preserved for both.

The preceding descriptions show that instead of four species of *Catostomi with a long dorsal*, mentioned in Dr. Storer's Synopsis of the fishes of North America, as Catostomus elongatus and Bubalus and Sclerognathus Cyprinus and Cyprinella, we have not less than four distinct genera of this type: Carpiodes, Bubalichthys, Ichthyobus and Cycleptus, numbering together sixteen or seventeen species, fourteen of which I have been able to describe and minutely to compare with one another, having specimens of them in my own collection.

It is a fact worth mentioning that the whole of this type is wanting in the waters of the Pacific slope of our continent, from which indeed a single species of the genus Catostomus proper is known thus far.

Moxostoma, Raf.

Most authors refer the species of this genus to Catostomus proper. DeKay however refers them to Cuvier's genus Labeo, though they bear only a remote resemblance to it. I have been unable to trace the etymology of the name Moxostoma. It may be a misspelling for Myzostoma, but in that form the name is already applied to a genus of worms.

The species of this genus contrast greatly with those of all other genera of the family of Cyprinoids, by the total absence of external openings in the lateral line, visible upon the scales. There is indeed no *row of perforated scales upon the sides of the body* to mark the main course of the system of tubes, pervading the skin in most fishes, and the pores traversing the skin which covers the skull and cheeks, as well as the lower jaw, are so minute as to escape the unarmed eye. In this respect the genus Moxostoma differs greatly from all other abdominal fishes in which the lateral line is distinctly marked by a series of tubes traversing a prominent row of scales along the sides, and extending through the mastoids to the forehead, and along the preopercle to the symphysis of the lower jaw. This total absence of an externally visible lateral line is compensated by the presence of a few deeper radiating furrows in the posterior field of all the scales.*

The longitudinal diameter of the scales exceed greatly the transverse, but the scales are imbricated in such a manner that the portion visible externally appears higher than long. The centre of radiation is placed in the middle of the scales; there are no radiating furrows upon the lateral fields, those of the posterior field are fewer and deeper than those of the anterior field; the concentric ornamental ridges of the posterior field are also much broader and farther apart than those of the lateral and anterior fields. The scales are smaller upon the anterior portion of the body than upon the sides. Another remarkable peculiarity of this genus consists in the great difference there is among the adults in the form of their fins in the different sexes. The young also differ strikingly from the adults both in form and coloration: the mouth is not surrounded by such thick lips, nor turned so far downwards, so that they may easily be mistaken for young Leucisci, and as they are marked with a broad, longitudinal black band extending from the snout through the eye to the end of the tail, they bear the closest resemblance to the Cyprinus atronasus of Mitchill, (my Rhinichthys atronasus) and have more than once been mistaken for that species. This lateral band which I have observed in the young of all the four species of this genus, which I have had an opportunity of examining, gradually fades

* In the genus Mugil we observe another extreme in this system of tubes, every scale from back to belly, being perforated by a tube, as the lateral line alone shows them in most fishes; in other fishes, such as our *Rhombus cryptosus*, we have still another arrangement; for besides the perforations of the scales of the lateral line, there are in this fish, several rows of similar holes above and below the lateral line, and along the base of the dorsal, and below the insertion of the pectoral, all of which converge towards the upper angle of the thoracic arch and open into the sinus of Cuvier.

and finally vanishes entirely in specimens of about three inches in length. Such a young specimen of our eastern species has been described by Lesueur as Catostomus vittatus. The body of Moxostoma is elongated and somewhat compressed; though stouter than that of the Ptychostomus and Catostomus proper; its greatest depth is above the ventrals.

The head is small; the small mouth opens obliquely forwards and downwards; when open the lower jaw is quite prominent. The lips are small and transversely ridged; the lower one is slightly bilobed.

The dorsal is over the ventrals; its length considerably exceeds its height in the males; in the females these dimensions are more nearly equal. The pectoral and ventrals are more pointed and longer in the males than in the females. The lower margin of the anal fin is bilobed in the males, while in the females it is simply emarginated; in both sexes, the anal, when bent backwards, reaches the caudal.

The pharyngeal bones have a greater resemblance to those of the genus Ichthyobus, than to any other of the tribe of Catostomi; the symphysis however is shorter, and the teeth are neither so minute, nor so numerous; they increase also more rapidly in size from above downwards, and are more strongly curved inwards; their cutting edge is slanting outwards, the innermost edge rising into an acute point, which is more prominent in the middle and upper teeth, than in the lower ones. Fig. 5, *a*, repre-

5.

a *b* *c* *d*

sents the right pharyngeal of Moxostoma oblongum, *b* one of the lower teeth in profile; *c* another in the same position; *d* the same, from the sharp side.

Former investigators, unconscious of the marked differences which exist in this genus between individuals of different sexes and ages, in different seasons of the year, have described a number of nominal species, which may now safely be reduced to their true relations. DeKay, in his Natural History of the State of New York, describes the species so common in the Eastern States, under no fewer than five different names, as Labeo gibbosus, Labeo elegans, Labeo esopus, Labeo oblongus, and Catostomus tuberculatus, and mentions it a sixth time under the name of Catostomus vittatus, given to the young by Lesueur. Dr. Storer in his synopsis of the fishes of North America, has it under five different names, as Catostomus gibbosus, oblongus, elegans, esopus, and vittatus. The oldest name applied to this fish being that of Cyprinus oblongus, introduced by Dr. Mitchell in his Report of the fishes of New York, the specific appellation of *oblongus* must of course be preserved for it. Since DeKay has represented four forms of this species, I may avail myself of his figures to give an idea of its variations: *Catostomus tuberculatus*, Pl. 31, fig. 97 represents the male in the spawning season, with tubercles upon the snout, a long dorsal and a lobed anal. DeKay mentions its appearance in April. *Labeo oblongus*, Pl. 42, fig. 136, is an adult male in winter, with a long dorsal and a lobed anal, but without tubercles. DeKay observed its appearance in December. *Labeo gibbosus*, Pl. 32, fig. 101, is a younger male, with less deeply lobed anal; *Labeo elegans*, Pl. 31, fig. 100, is a young female in winter dress, with a shorter dorsal, trapezoidal anal and a more slender form. Dekay observed his specimens in October and November; *Labeo Esopus* is an adult female with a somewhat emarginate anal, broader than the preceding; *Catostomus vittatus*, Lesueur, with "a black stripe passing from the snout through the eye to the caudal fin, dividing the body equally" in the young. I have traced all these differences in specimens taken from the same pond in different seasons of the year. Lesueur, who first described Catostomus gibbosus and tuberculatus, already remarked that these species may be founded upon the two sexes of one and the same species. Instead of availing himself of this hint and ascertaining its correctness, DeKay has only increased the confusion by describing three other forms as so many additional species, and he has unfortunately been followed by later compilers. This species ranges through the States of Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, and Maryland. I have obtained specimens from the Susquehannah through the kindness of Prof. S. S. Haldeman, from Carlisle, Pa., through Prof. Baird, from Chestertown and Havre de Grace, Maryland, through F. R. Williams, Esq. and Dr. Wroth. I entertain serious doubts as to the identity of the form found in Lake Champlain. The other species of the genus are Catostomus Sucetta, *Les.* (Cyprinus Sucetta, *Lacep.*), from Charleston, and other localities in South Carolina. This species occurs also in Georgia. I have received specimens from that State from Athens, through the kindness of Prof. J. Le Conte, and from the Altamaha, through G. Belknap, Esq.

The third species is the Catostomus (Moxostoma) anisurus, *Raf.*, from the Ohio, which I have found as far west as the vicinity of St. Louis (Missouri), and of which specimens have been kindly forwarded to me from the Scioto River, by J. Sullivant, Esq., from Lake Erie, by Dr. Kirtland, from Lebanon, Tennessee, by Prof. J. M. Safford, from Quincy, Illinois, by Dr. Watson, and from Milwaukie, Wisconsin, by Prof. Lapham. I have obtained a new species from the neighborhood of Mobile, Alabama, through the kindness of Albert Stein, Esq. of Springhill, which I shall call *Moxostoma tenue*, as it differs from the others, by its more elongated form, and less prominent differences between males and females. I would unhesitatingly refer also *Catostomus congestus*, B. and G., to this genus, from the characters assigned to this species, were the lateral line not described as running straight along the middle of the side, when the absence of a lateral line is the most prominent character of the genus Moxostoma. Not having however seen a specimen, I must leave it for Messrs. Baird and Girard to determine whether it is a genuine Catostomus, as the genus is now circumscribed.

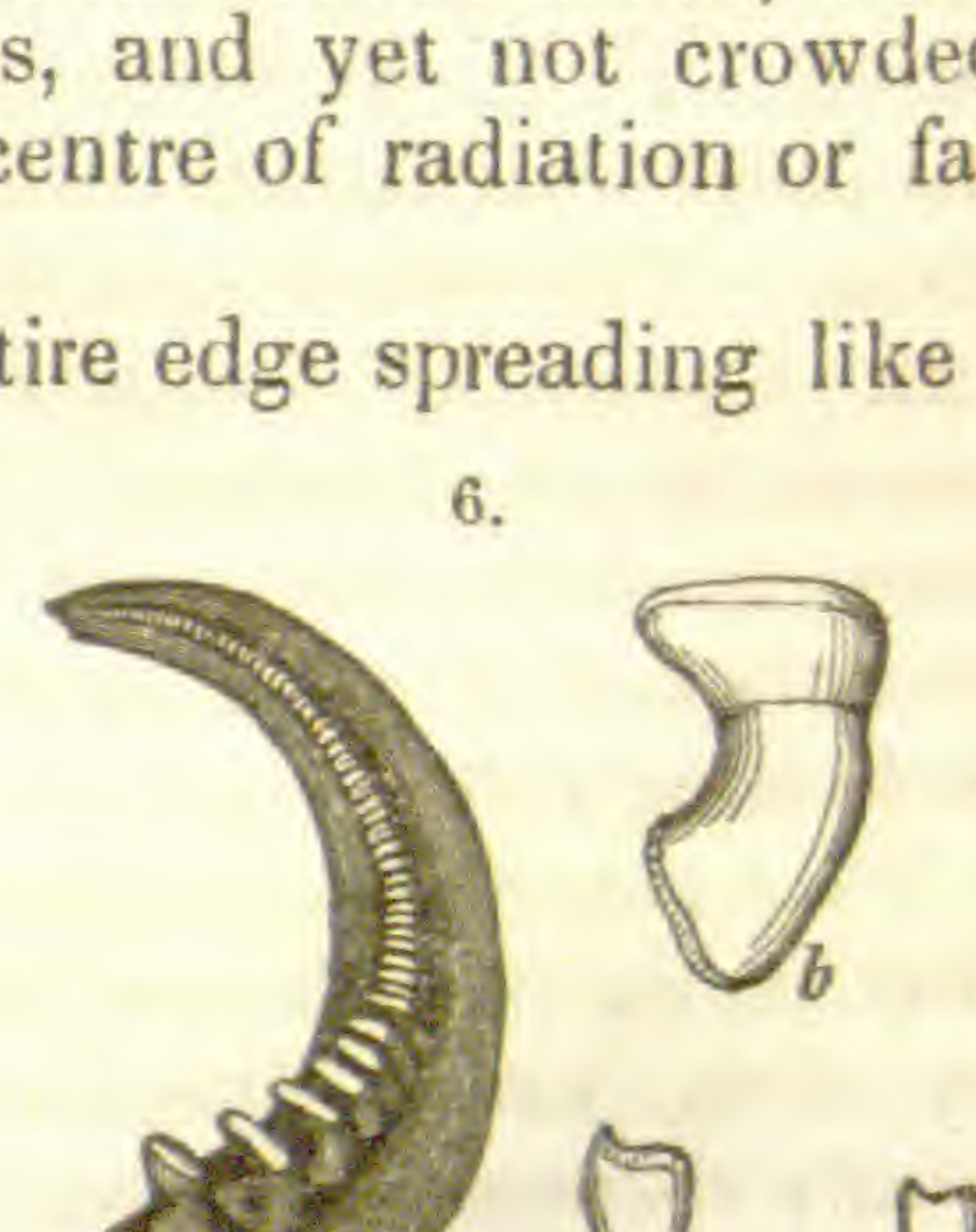
Ptychostomus, Agass.

In respect to form of body and the structure and position of fins, this genus does not differ from Catostomus proper, but may be distinguished by the following structural peculiarities. The lips are marked by transverse ridges or folds, and hardly bilobed below; they are not papillated as in Catostomus proper. The generic name of this type is derived from this character of the lips. The head is shorter and stouter. The dorsal is longer than it is high, but in the males it is longer in proportion than in the females. The anal of the male is also broader than that of the female, and its lower margin lobed, while in the female it is trapezoidal and narrow. Such differences between the sexes do not exist in the species of Catostomus proper.

The scales are as large on the anterior as on the posterior parts of the body; their vertical diameter about as great as the longitudinal, so that the scales are nearly quadrangular with rounded edges; the ornamental concentric ridges not longer nor broader upon the posterior than upon the lateral and anterior fields; the radiating furrows few, only one or two in the posterior field, and one on each side, limiting that field from the lateral fields; those of the anterior field are more numerous, and yet not crowded. Tube of the lateral line arising in the centre of radiation or farther back upon the posterior field.

The pharyngeals are strong, their entire edge spreading like a wing, and that spreading margin is separated from the symphysis by a deep emargination. The teeth, increasing rather rapidly in size from above downwards, are more apart from one another than in the preceding genera, and arched inwards as in Moxostoma; the inner edge of the lower ones square, its inner margin rising into a broad cusp in the middle and upper teeth. Fig. 6, *a*, represents the right pharyngeal of Ptychostomus macrolepidotus from its inner surface, *b* one of the lower teeth, *c* and *d*, teeth from the middle and upper part of the arch.

6.



I know four distinct species of this genus from personal examination, all well described and figured by Lesueur and Dr. Kirtland, viz: Catostomus Aureolus, *Les.*, Catost. Duquesnii, *Les.*, Catost. macrolepidotus, *Les.*, and Catost. melanops, *Rafin.* The Catost. Sueurii, *Rich.*, Fauna Boreali-Americani, I have not seen myself, nor the Catost. Carpio, *Val.*, but from their description, and from the figure given of the latter by Valenciennes, I am inclined to believe that Cat. Sueurii is founded upon the male of Catost. aureolus, *Les.*, and that C. Carpio is the male of C. macrolepidotus. The circumstance that I have found C. aureolus in the Lake Superior in lat. 47° would connect the range of this species from the middle western States through the great Canadian Lakes to the locality from which Dr. Richardson (now Sir John), obtained his C. Sueurii in lat. 54. DeKay's Cat. Oneida is probably also C. macrolepidotus. That it belongs to the genus Ptychostomus, the description of DeKay leaves no doubt, and his remark that the scales are *very large*, points rather to C. macrolepidotus than to Duquesnii. It cannot be a distinct species, since three species only of this genus are found within the natural boundaries of the fresh-water fauna of New York:—Catost. aureolus, Catost. Duquesnii, and Catost. macrolepidotus, one of which, C. aureolus, DeKay has himself accurately described. Rafinesque's Catostomus erythrurus is identical with Lesueur's Cat. Duquesnii. As to Catostomus melanops, *Raf.*, it is a well characterised species, which Dr. Kirtland has for the first time satisfactorily described; but the species Valenciennes described afterwards under the name of C. fasciatus from specimens sent him by Lesueur under that name, is synonymous with it, as is also his own Cat. melanotus. Judging from the form of the anal, and the position of the dorsal, I believe that Catostomus insignis, *B. & G.*, which I have not seen, also belongs to this genus, though no mention is made in their description of the character of the lips, so important in this tribe, as Lesueur has already shown. The black dot at the base of each scale, brings it near Ptychostomus melanops.

The geographical distribution of these species presents some interesting peculiarities; for three of them, C. aureolus, Duquesnii and macrolepidotus are found in the Canadian Lakes, and yet they do not cover the same areas, C. aureolus, extending chiefly northwards, Catostomus Duquesnii westwards, and C. macrolepidotus eastwards; C. melanops on the contrary, is only found in the West and Southwest, and not in the great Lakes. If, upon close examination, Catostomus insignis should prove to belong to this genus, it would furnish additional evidence that the Ptychostomi with dotted scales are the southwestern type of the genus.

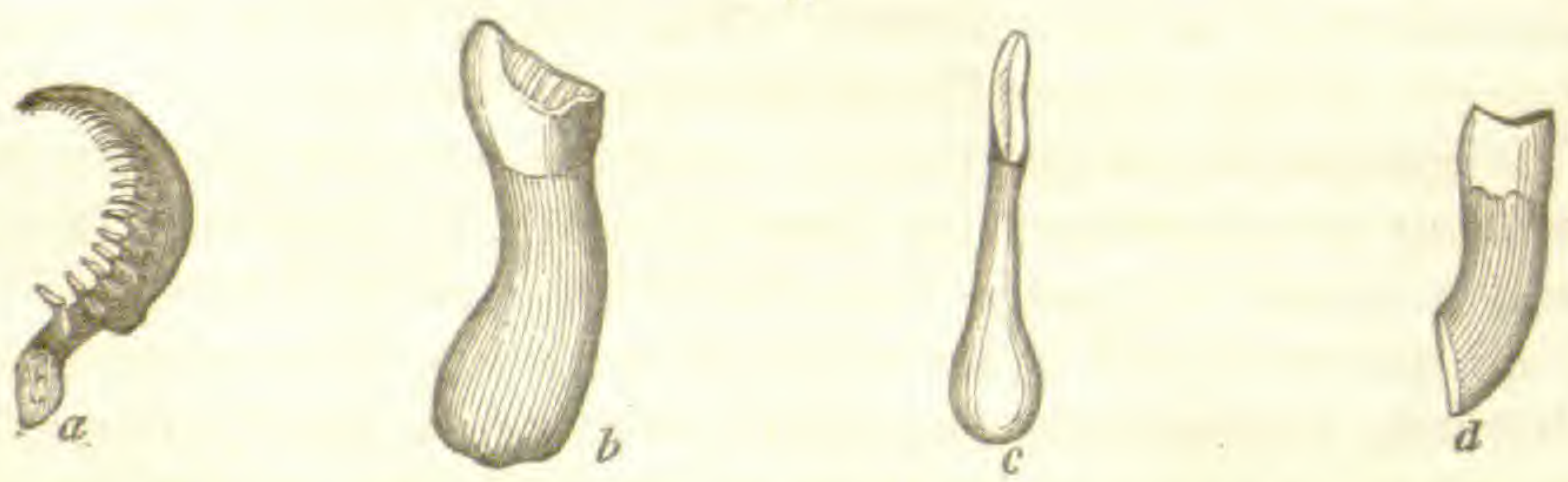
Hylomyzon, Agass.

The name of this genus is a mere translation of the vernacular name of its type, the Mud-Sucker of the West, framed in imitation of Petromyzon, but expressing its habits of living in the mud. The body is stout and heavy in front, and tapers off rapidly from the shoulders towards the tail; behind the dorsal it is nearly cylindrical in form.

The short quadrangular head is broad and flat above, its sides are vertical. The eyes are of moderate size, and elliptical in form; the superorbital ridges are elevated above the general level of the head. The mouth is inferior, and encircled by broad, fleshy lips, which are covered by small granules or papillæ. The lower lip is bilobed. The dorsal is over the ventrals, and nearer the head than the tail; its height and length are nearly equal. The pectorals and ventrals are broad and rounded, the anal fin is slender and reaches the caudals. The scales are largest on the anterior portion of the body. They are slightly longer than high; the ornamental concentric ridges of the posterior field are broader and farther apart than those of the lateral and anterior fields; no radiating furrows upon the lateral fields; those of the anterior and posterior fields rather remote, about equal in number. Tubes of the lateral line arising from the centre of radiation.

The teeth are compressed, so that their sharp edge projects inwards; at the same time they are slightly arched inwards and inserted obliquely upon the pharyngeal bones. They increase gradually in size and thickness from above downwards. The masticating ridge of the teeth is transverse, compressed in the middle, and sharp; its upper and lower edges are rounded and more projecting, the inner point however projecting more than the outer one. Fig. 7, *a*, represents the right pharyngeal of Hylomyzon nigricans, *b* and *c*, one of the lower teeth from two sides, and *d* one of the middle teeth in profile.

7.



There is no species in the whole tribe of Catostomi which has been described under so many names as the type of this genus. It was first described by Lesueur under the name of Cat. nigricans, from specimens obtained in Lake Erie. At the same time he described specimens from Pipe Creek, Maryland, under the name of Catostomus maculosus, suspecting however, what is true, that this may be only a variety of the former. Soon afterwards Rafinesque described the same species from the Ohio and its tributaries, under four different names, as Catostomus fasciolaris, C. flexuosus, C. megastomus, and C. xanthopus. Again, his Exoglossum macropterum, for which he afterwards proposed the generic name *Hypentelium* is only the young of the same species; finally Valenciennes, though copying the description of Cat. nigricans and C. maculosus from Lesueur's paper, describes anew original specimens of the former species, which Lesueur had sent to the Jardin des Plantes under a new name, as Cat. planiceps. We have thus eight specific names for a single species, the only one thus far known of this genus. In order to substantiate this assertion. I ought to state that though there are no marked differences between males and females in this genus, which may lead to the establishment of nominal species, as in the genus Moxostoma, the young and adult differ greatly in their coloration, being first strongly banded transversely, then more mottled, and afterwards the bands and blotches of dark color fading into isolated specks and finally disappearing entirely, the lower fins, and the abdomen becoming in the same proportion more brightly tinged, especially in the spawning season, as the upper parts of the body grow lighter. These four stages have misled Rafinesque to distinguish four species; his C. fasciolaris, about eight inches long, with *small transversal black lines*, is described from a juvenile specimen, his C. flexuosus *from ten to twelve inches long, more plain*, is described from nearly full grown specimens; his C. megastomus, *yellowish beneath*, appearing in shoals in March. is drawn from a male in the spawning season; his C. xanthopus, *with lower fins yellowish* is a younger male; his Exoglossum macropterum is drawn from a *very young* specimen with fully protruded mouth. Thus we account for all the nominal species of Rafinesque. That he should have taken no notice of Lesueur's descriptions, is the natural consequence of the assumption upon which Rafinesque works throughout, that the fishes of our western waters differ uniformly as species from those of the Atlantic streams. The mistake of Valenciennes arose from another source. It was the habit of Lesueur to send to the Jardin des Plantes, original specimens of all his species, carefully labelled, whether he had published descriptions of them or not, and we find in the great Histoire Naturelle des Poissons, many species described by Cuvier and Valenciennes, under Lesueur's name, even though the latter had never himself published any notice of them.* Of Catostomus nigricans, Lesueur sent two dried speci-

* How honorably this course contrasts, with the race some Naturalists are running, for the questionable distinction of being the first to name species, using even all sorts of unworthy tricks to secure them.

mens to Paris from the Wabash, the labels of which seem to have been lost; at least Valenciennes, who describes them as Cat. planiceps, says he received them from Lesueur without a name, not recognising that they were original specimens of the *Catost. nigricans* of Lesueur, as the description of Valenciennes clearly shows them to be. Hylomyzon nigricans has the widest geographical distribution of all our Catostomi. It occurs in the northern and middle Atlantic States, in all the great Canadian Lakes, with the exception of Lake Superior, through all the middle western States as far as Missouri. Its southernmost localities are Lebanon, Tennessee, from which place I have received specimens through Prof. J. M. Safford, and Huntsville, Alabama, whence J. H. Newman, Esq., sent me also several specimens. Its westernmost range is in the Osage River, Missouri, from which Mr. G. Stolley has sent me quite a number. I have repeatedly and most carefully compared with one another the specimens from the remotest localities, without finding the least specific difference between them.

Catostomus.

I have retained the name of Catostomus for the type to which it was originally applied by Forster.

The body is elongated, fusiform and slightly compressed. The snout is short and blunt, and projects but little beyond the mouth, which is inferior.

The lower jaw is short and broad; the lips are fleshy and strongly bilobed below; their surface is conspicuously granulated or papillated. The head is considerably longer than high. The dorsal is large, and mostly in advance of the ventrals; its length is greater than its height. The anal fin is long and slender, and reaches the caudal.

The sexual differences so conspicuous in the genus Moxostoma and Ptychostomus, are hardly to be noticed in this genus. The other fins are of moderate size, and more or less pointed.

The scales are much smaller on the anterior than on the posterior portion of the body; nearly quadrangular, with rounded angles, but somewhat longer than high; the ornamental concentric ridges of the posterior field broader than those of the lateral and anterior fields; the radiating furrows more numerous than in Hylomyzon and Ptychostomus, and encroaching upon the lateral fields, where in some species, they are nearly as numerous, as upon the anterior and posterior fields. Tubes of the lateral line wider than in Hylomyzon and Ptychostomus, extending from the centre of radiation to the posterior margin.

The pharyngeals are stout and compact, the outer margin not so spreading as in Ptychostomus; the teeth are blunter and larger comparatively than in any other genus of the tribe, increasing more rapidly in size from above downwards, so that those of the middle of the arch are already of the same cast as those of the lower part of the comb; their crown is blunt and the inner edge rises into a blunt cusp. Fig. 8, *a*, represents the right pharyngeal

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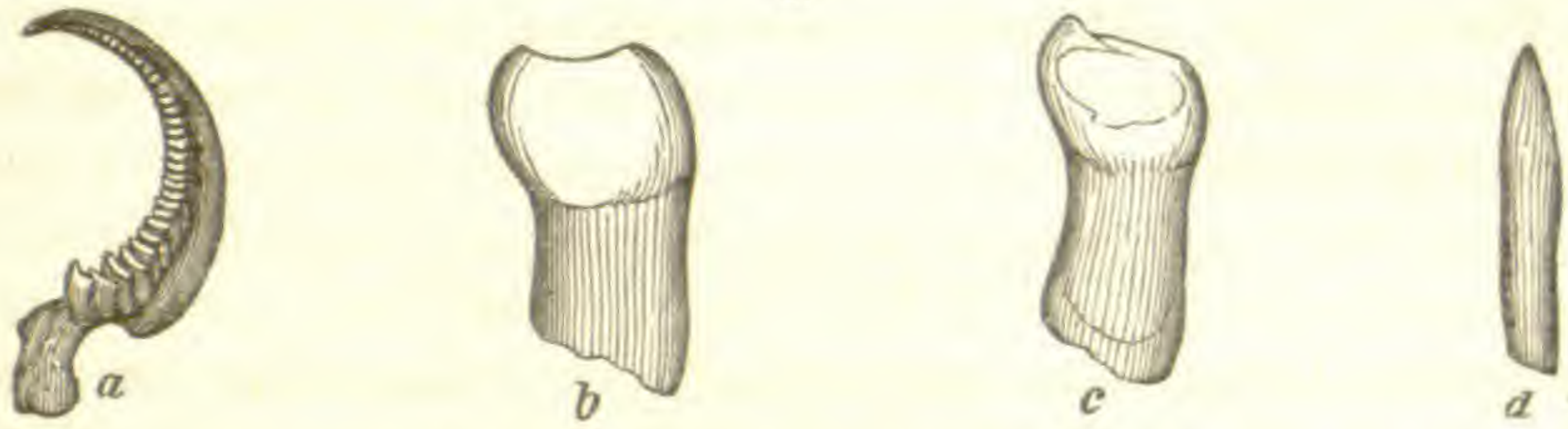

a *b* *c* *d*

of Catostomus communis, *b* being one of the lower teeth, *c* one from the middle of the arch and *d* a side view of the same.

This genus has representatives over a much greater geographical area than any other of the tribe, some are found even as far north as the fur countries of North America, others in Lake Superior; farther south they occur in all the fresh waters of the United States as far as Texas and the northern boundaries of Mexico, whence Mr. John H. Clark has obtained several new species described by Messrs. Baird and Girard in the Proceedings of the American Academy of Natural Sciences of Philadelphia, for 1854, page 27. I have myself received a new species from N. Mexico, through the kindness of Dr. Henry of the U. S. Army and another from Georgia through Prof. J. LeConte. Sir John Richardson mentions their occurrence in the Columbia River. I have myself received a new species from San Francisco, California, from my friend T. G. Carey, Jun., Esq. Valenciennes refers to this genus, a species described by Tilesius under the name of Cyprinus rostratus, from Siberia. This would be the only Catostomus from the old world. As the species of this genus are closely allied to one another and their distinguishing characters could not be plainly illustrated without figures, I will not enter into more details about them for the present and limit myself to enumerating them and describing the species from San Francisco.

The first species known is that which Lesueur has called *Catostomus Hudsonius*, the Cyprinus Catostomus of Forster. Next to it comes my *C. Forsterianus*, for which I regret having adopted that name, as it conflicts with the *Catostomus Forsterianus* of Richardson (my Cat. Aurora), an entirely different species. There are however still some difficulties about these northern species to be solved, as it remains doubtful whether there are three or four or only two species ranging from the great Canadian Lakes northward. I am unable to find any difference between Catostomus teres, *Les.* (Cyprinus teres, *Mitchill*) and his own Cat. communis, to which Cat. gracilis, Kirtland, seems also to belong, as he himself has more recently admitted. Catostomus Clarkii and Catostomus plebeius, *B. & G.*, are distinct species.

For their Catostomus congestus and insignis I must refer to my remarks under the head of Moxostoma and Ptychostomus.

Catostomus Bostonensis, *Les.*, Cat. pallidus, *DeKay*, and florealis, *Baird*, are so closely allied that I am unable to distinguish them; I have however seen only one specimen of the latter. As to Cat. Tilesii, *Val.*, it has not been seen since Tilesius described it under the name of Cyprinus rostratus, and its true affinities remain still doubtful.

Catostomus occidentalis, Agass.

This species resembles very closely C. communis, in general outline and appearance, but differs from it in the following respects. The head is less square; the profile steeper, but the snout is more pointed. The sides of the head are nearly triangular instead of trapezoidal and converge more rapidly forwards. The longitudinal rows of tubes upon the top of the head are more waved. The mouth is smaller; the hind margin of the lower lip is perpendicularly under the anterior nasal opening. The lower border of the eye and the posterior angle of the opercle are on the same horizontal line. The centre of the eye is nearer the anterior edge of the upper lip than the hind or lower angle of the subopercle. The opercle and subopercle are larger and longer and together form one-half of the side of the head. The lowest angle of the opercle is less acute, and its hind angle smaller; its waving border is directed more forwards and backwards.

The pectorals are broader; the dorsal is longer, considerably emarginated above, its last rays shorter and its upper angle more acute. The ventrals are more pointed.

The scales on the anterior part of the body are smaller.

TRIBE OF CHONDROSTOMI.

There lives in Europe a remarkable fish of the family of Cyprinoids which was first described by Linnæus as Cyprinus Nasus, and in which I recognised about twenty years ago the type of a distinct genus, *Chondrostoma*. This fish differs so strikingly from the other Cyprinoids that Heckel in his synopsis, considers it as the type of a distinct tribe, to which he ascribes the following characters:

Os inferum in aciem cartilagineam attenuatum, labiis et plica menti deficientibus; rostrum incrassatum; preoperculum ante occiput. Pinna dorsalis subelongata, analis brevis, utraque radio osseo nullo. Tractus intestinalis longissimus tenuissimus.

The cartilaginous lips, with a sharp edge of the lower lip at least and the chisel-like teeth, with a narrow flat grinding surface, supported upon pharyngeals the outer margin of which has a spoon-shaped lateral expansion, truly characterise this tribe as a natural group in the family of Cyprinoids.

Thus far, America has not been known to produce any representation of this type. I for the first time called the attention of Naturalists to its existence in our waters in my "Notice of a collection of fishes from the southern bend of the Tennessee River,"* but the scanty materials I had then in my possession did not allow me to make a thorough comparison between the representatives of the old world and those of the new, and even now I am unable to extend my investigations to the Asiatic and African species described by Buchanan, McClellan, Sykes, Russell and Valenciennes. But even between the American and European members of this tribe, most of which I have now before me, there are marked differences and striking analogies. In the first place, I would remark that the genus Exoglossum of Rafinesque, which is entirely peculiar to North America, though placed near Catostomus by all ichthyologists who have had an opportunity of examining it, in reality belongs to the tribe of Chondrostoma, the very peculiar shape of its mouth being only the extreme of the feature characteristic of that genus and arising from the reduction and discontinuity of the lower lip near the symphysis of the two branches of the lower jaw and the great projection of the symphysis itself. The pharyngeal teeth moreover have no resemblance to those of Catostomus, either in their form or in their arrangement, but approximate closely the common type of Leuciscus and Chondrostoma, between which they are intermediate.

The genus Pimephales of Rafinesque, which, like Exoglossum, contains also exclusively American species, next deserves to be noticed here. Since Rafinesque, Dr. Kirtland seems to be the only ichthyologist, who has observed the type upon which this genus was founded. We find an excellent figure of it, accompanying his paper upon the fishes of the Ohio and its tributaries, published in the 3d vol. of the Boston Journal of Natural History. This genus seems at first to resemble more the type of Leuciscus than that of Chondrostoma by its general form, and yet the attenuated, sharp, somewhat truncated lower lip, and the thickened snout leaves no doubt as to its real affinity with Chondrostoma. The fish described by Dr. Kirtland as Exoglossum dubium, of which Valenciennes' Exoglossum spinicephalum is the male in the spawning season, is another representative of this tribe, still more approximating the European genus Chondrostoma, but differing from it, in having only four pharyngeal teeth on each side, instead of six, and which I shall call *Campostoma.* Finally, among the fishes collected by the U. S. Exploring Expedition, under the command of Capt. Wilkes, there is a species found in the Columbia River, coming nearer to Heckel's genus Chondrorhynchus, than to my Chondrostoma, which however constitutes another genus peculiar to the Pacific slope of North America, which I shall call *Acrocheilus.*

* Printed in this Journal, vol. xvii, 2d ser. p. 357.

It appears thus that far from being deficient in representatives of the tribe of Chondrostomi, North America has a greater number of them and more diversified ones than Europe, belonging to four distinct genera: Exoglossum, *Raf.*, Pimephales, *Raf.*, *Campostoma*, Agass., and *Acrocheilus*, Agass.; to which must be added two other new genera to be described hereafter, founded also upon North American species: *Hybognathus*, Agass., and *Hyborhynchus*, Agass. I am unable to say whether the genus *Cochlognathus*, B. and G., belongs to this tribe or not, as I have had no opportunity of examining it.

Acrocheilus, Agass.

The type of this genus has a general resemblance to the type of my genus Chondrostoma, inasmuch as the mouth opens transversely under the snout, and has a hard cartilaginous or rather horny edge. But it differs from that genus in having a solid rim along the upper lip similar to that upon the lower, and in the character of its scales, which resemble more those of the group of Barbus, than those of the common type of Leuciscus or Catostomus.

As a genus I would characterise it by the peculiar structure of the edging of the mouth, which in the lower jaw constitutes a transverse broad flat plate, very similar in appearance to the dental plates of Myliobates, being thicker along the outer edge and tapering gradually along the inner edge. This transverse plate is square and cut at right angles externally towards the symphysis of the two jaws. In consequence of this peculiar structure of the margin of the mouth and its armature, the lower jaw is as it were cut transversely, and has in no degree the rounded outline about the symphysis of its branches which is observed in most Cyprinidæ. The membranous fold which extends from the suboperculum along the interoperculum towards the symphysis of the lower jaw is limited by a deep furrow which terminates somewhat behind the horny plate of the lower jaw. Along the inner edge of the intermaxillary bone there is a similar transverse bony plate which is, however, much narrower and rounded, folding over that of the lower jaw when the mouth is shut. Sideways and above, the intermaxillaries are surrounded by a fleshy lip which is bent forwards at the angle of the mouth to unite with the edge of the horny plate of the lower jaw. The upper maxillary bone forms a slight projection behind the angle of the mouth in a depression arising from a membranous fold upon the sides of the lower jaw, and below and behind the first suborbital bone. There is not the slightest rudiment of a tentacle in the angle between the lower termination of the intermaxillary and upper maxillary. But what is particularly striking in the structure of this fish is the circumstance that the horny covering encircling the mouth is deciduous, at least in specimens preserved in alcohol, showing that the attachment of this indurated edge is not very close. The surface to which the horny plate of the lower jaw was attached appears fibrous upon the removal of that plate, and the fibres run in a longitudinal direction up and down. The tissue of the plate itself is also fibrous and the fibres have the same longitudinal direction throughout its thickness, so that the plate breaks very readily at right angles with its own greater diameter.

The nostrils, two on each side as in all Cyprinidæ, consist of a tubular opening in advance and a large crescent-shaped opening behind.

The opercular apparatus and the branchiostegal rays, present no peculiar characters. The branchiostegal membrane however unites with the skin under the chin on the anterior margin of the humerus, so that the branchial opening does not extend to the sides of the tongue bone.

The dorsal begins opposite the insertion of the ventrals, which are themselves somewhat nearer to the anal than to the pectorals. The dorsal extends as far back as the anterior margin of the anal. It has three small rays in advance of the longest simple ray which is followed by ten branching rays, the last of which is properly a double ray.

All these rays are deeply divided longitudinally and transversely articulated. The caudal is very powerful, and remarkable for the many simple rays which it has along the base of its two lobes, there being seven above and seven below, gradually increasing, so that the longest reaches nearly half the length of the longest simple ray which edges the fin above and below. The inner rays are all deeply divided longitudinally and transversely articulated. The number of rays in the upper and lower lobe is equal, eight in both. There seems however to be a middle ray, so that properly speaking there are seven rays in the upper lobe, one in the middle, and eight in the lower lobe.

The tail is deeply furcate. When the fin is shut, the innermost rays overlap each other, so that the caudal appears much narrower than when fully expanded, but the outer rays in both lobes remain in one plane, and do not overlap each other at all. The anal consists of two simple short rays in advance of the long simple one followed by nine articulated rays which, when the fin is closed, overlap each other; so much so that the fin appears much narrower when bent backwards than it is in reality. My attention not having been called formerly to the manner in which the fins shut until I began to study the Balistidæ, I am unable to say how far in various families, the closing of the fins varies; but it is a point to which the attention of Zoologists should be directed in future, as it will no doubt afford interesting characters in addition to those exhibited by the structure of the rays themselves. As far as I can ascertain, it has been admitted among ichthyologists, that the change of form in the fins arose from the rays being brought close together, or stretched asunder; I find, at least, no mention in any description, of rays overlapping each other, as I have shown it to be the case among Balistidæ, and as is also the case among many others. In the Scomberoids, for instance, the rays of the vertical fins are remarkably spreading when contrasted with those of the Balistidæ, or those of the genus Acrocheilus described here. The ventrals are rather large, somewhat similar in their rounded form and the thickness of their rays, to the ventrals of the genus Tinca; the first ray especially is thick and simple. It is followed by eight articulated rays. The pectorals are also somewhat rounded, but not so much as the ventrals, the upper angle projecting more. Their first ray is also thick and simple, and is followed by sixteen articulated rays gradually tapering, the last of which, however, are simple. In its general form, the fish upon which this new genus is founded, has considerable resemblance to the European Chondrostoma Nasus, and I should not be surprised at all if, upon a superficial examination, it had been identified with it, notwithstanding the generic and specific differences, to which I have already alluded. The scales, however, present a striking difference. They have not, as in Chondrostoma, the ordinary type of Leuciscus, but resemble rather the scales of Barbus in their elongated form, their small size, their many radiating furrows diverging in every direction, and their ornamental pigment cells which are especially numerous along the posterior margin. The centre of radiation is far in advance of the centre of form. The lateral line arises above the posterior and upper angle of the operculum, and is first slightly bent downwards, so that it follows in its course upon the side, a direction nearer the abdominal margin than the back; but upon the tail it is strictly upon the middle of the side. The tubes of these scales arise in the middle of the anterior field, and taper towards the middle of the posterior field, where they terminate. The scales along the back, upon the neck, between the pectorals, and along the lower margin of the abdominal cavity, are much smaller than upon the middle of the sides. There is a naked space behind the pectorals in which the muscular swelling of the base of that fin is received, when the fin is bent backwards. There is also a narrow smooth space above the ventrals; along the base of the dorsal and anal the scales do not extend quite to the base of the rays, but upon the caudal they cover their base completely and even extend somewhat along the sides of the middle rays.

Water pores besides those of the lateral line, are very distinct upon the neck in advance of the scales. The whole surface of the skin covering the skull seems also to be perforated by a set of smaller pores, but larger ones follow the margin of the pre-operculum, and the lower jaw as well as the suborbitals and mastoid bones.

Unfortunately the two specimens collected in Columbia River are deprived of their intestines, and in one of them only, were the pharyngeal bones, with their teeth, preserved; but these afford further evidence of the correctness of my view in considering these fishes as a type of a distinct genus peculiar as far as is now known to the northwest coast of America. There is but a single row of teeth and only five teeth in that one row on the left and four on the right side. The isolated teeth stand on a cylindrical peduncle swelling into an oblique club-shaped crown, which is elongated externally into a sharp hook, but the inner surface is cut obliquely like the incisors of Rodents, and present a flat grinding surface resembling closely the dentition of Chondrostoma and Chondrochilus, differing however in the more club-shaped form of the teeth, and the sharp terminal hook, and also the smaller number of teeth in one row. Fig. 9, *a*, represents

9.

a *b* *c* *d* *e*

the right pharyngeal of Acrocheilus alutaceus seen from behind, *b* the same seen from its inner margin, *c* one tooth in profile from its upper side, *d* another from its lower side, and *e* the same from the inner side to show the grinding surface. As a further resemblance to the genus Chondrostoma, I should mention the circumstance, that the peritoreum is also black.

Acrocheilus alutaceus, Agass. and Pick.

Caught at Willamet Falls, and in Wallawalla River. Nose prominent and rounded.

Tail rather slender. Caudal large. Dorsal much larger than the anal. The color light brown above, (there being a white and very fine line on the edge of each scale,) blending into yellowish brown upon the sides, and passing into pure white upon the abdomen. Gill-cover golden brown. Dorsal and caudal of the same color as the sides of the body. Pectorals orange, gradually paler towards the base. Ventrals as the pectorals, but more uniformly orange. Anal also orange, but more bright and reddish. It occurs in the rapids and falls of the River. Is caught by the natives while fishing in the Falls for Salmon.

(*To be continued.*)

ART. XIII.—*Thoughts on Solution and the Chemical Process;* by T. S. HUNT.

BY solution, as distinguished from fusion or volatilization, we understand in chemistry the production of a homogeneous liquid by the combination of two or more bodies, one of which must itself be in a liquid state, while the others may be liquid, solid, or gaseous. The solvent action of acids and alkalies upon bodies insoluble in water is by all admitted to be chemical in its nature; but according to Leopold Gmelin, "mixtures of liquids, and solutions of solids in liquids, (as of acids, alkalies, salts, oils, etc., in water and alcohol,) are by Berzelius, Mitscherlich, Dumas, and others of the most distinguished modern chemists, regarded as not chemical unless they take place in definite proportions." "Mitscherlich attributes such unions to *adhesion*, Dumas to *a solvent power* intermediate between cohesion and (chemical) affinity, and Berzelius refers them to *a modification of affinity*, while proper chemical combinations according to him result not from affinity, but from electrical attraction."—(*Gmelin's Handbook*, English ed., vol. i, p. 34.)

The learned author of the Handbook objects to these views that "they restrict the idea of a chemical compound within too narrow limits," and he elsewhere implies that the force which produces solution is a weak degree of chemical affinity. (Id. vol., p. 70.) The judicious Turner also speaks of ordinary solutions as instances of chemical union;* and Mr. J. J. Griffin has insisted upon the same view.† As these writers have not however sufficiently dwelt upon the important principle, rejected by so many names of authority, that *all solution is chemical union*, we propose to offer some considerations upon aqueous solution, and endeavor to show that the process presents all the phenomena of chemical combination. First, in the fact that the resulting saturated solutions are perfectly homogeneous; secondly, in the condensation and more or less perfect identification of volume observed in the process;‡ (some anhydrous salts dissolve in water without increasing its volume.) Thirdly, in the change of temperature which attends the process; thus oil of vitriol, hydrate of potash, and many anhydrous salts evolve heat when dissolved in water, while sal-ammoniac, nitre, and many hydrous salts produce cold by their solution. Fourthly, in the change of color which attends the solution of some salts, as the chlorids of nickel, cobalt, and copper.

* Elements of Chemistry, 7th ed., p. 139.

† L., E. and D. Phil. Mag., 3d Series, vol. xxix, p. 299.

‡ See my paper, *Considerations on the Theory of Chemical Changes, etc.*, this Journal [2], xv, p. 228, L., E. & D. Phil. Mag. [4], v, 526, and Pharm. Centralblatt, Leipzig, 1853, 849.

It must not be forgotten that the liquid state of these aqueous combinations is often an accident of temperature; alum and the rhombic phosphate of soda are liquids at 212° F., and bi-hydrated sulphuric acid is a crystalline solid below 46° F. The ease with which many of these compounds are destroyed by evaporation, and even by changes of temperature, is not to be urged as an objection to the chemical nature of the union. We need only compare the corresponding silver salts with the chlorid and iodid of gold, or the hydrochlorates of morphia and ammonia with those of caffeine and piperine, which lose their acid by a gentle heat, to learn how variable is the stability of admitted chemical compounds. Chemical affinity may be very feeble in degree.

According to Gay-Lussac one part of oil of vitriol will absorb from air saturated with moisture, fifteen parts of water, or more than eighty equivalents; terchlorid of arsenic requires eighteen equivalents of water to dissolve it, and the saturated solution unites with as much more water, evolving heat and forming a stable solution.* According to the experiments of Mr. Griffin in the paper cited above, the condensation which takes place in the solution of the acid is still perceptible with 6000 equivalents of water to one of SO_3. There appears however to be with many bodies a limit beyond which the affinity for water is satisfied, and the liquids being then mechanically mixed, gradually separate by reason of their difference in density, as is observed in dilute alcohol, and probably in some saline solutions† and metallic alloys.

Solution is a result of that tendency in nature which constantly leads to unity, condensation, identification. I have elsewhere with Kant defined chemical union to be interpenetration, but the conception is mechanical, and therefore fails to give an adequate idea. The definition of Hegel, that *the chemical process is an identification of the different, and a differentiation of the identical*,‡ is however completely adequate. Chemical union involves an identification not only of the volumes, (interpenetration mechanically considered,) but of the specific characters of the combining bodies, which are lost in those of the new species. Such is equally the case in aqueous solution, and we may say that all chemical union is nothing else than solution; the uniting species are as it were, dissolved in each other, for solution is mutual.

* Penny and Wallace, L., E. & D. Phil. Mag., Nov., 1852, p. 363.

† See Gmelin's Handbook, Eng. ed., vol. i, p. 111. Gmelin throws a doubt upon these experiments; but the satisfactory results obtained on a large scale, in applying this principle to the rectification of spirit of wine by a recently patented process, were communicated to the American Association for the Advancement of Science, at Washington in May, 1854, by Dr. L. D. Gale.

‡ Stallo's Philosophy of Nature, p. 453. See also p. 67, where Stallo insists upon the same view. To Hegel belongs the merit of having first among modern philosophers obtained a just conception of the nature of the chemical process, although in its application he was misled by the received terminology of the science.

Solution being then identification, the discussion as to whether metallic chlorids are changed into hydrochlorates when dissolved in water, is meaningless. Such a solution is a unity, in which we can no more assert the existence of the chlorid or of water, than of chlorine, hydrochloric acid, or a metallic oxyd, although these and many others are conceivable results of its differentiation. If the solution be one of chlorid of potassium, evaporation resolves it into water and the chlorid, but if chlorid of aluminum, it is decomposed by boiling into water, hydrochloric acid, and alumina, or in the case of the magnesian salt, into hydrochloric acid and an oxychlorid.

The precipitation of the sulphates of cerium, lanthanum and lime from their solutions by heat, and of most other salts by cold, is chemical decomposition or differentiation. Dilution may also effect decomposition in solutions; we have already said that the combination of terchlorid of arsenic $AsCl_3$, with 36HO is stable at ordinary temperatures, but a further addition of water causes the solution to divide into aqueous hydrochloric acid, and crystalline oxyd of arsenic. The precipitation of chlorid of antimony, and many salts of bismuth and mercury by water, is an analogous process. This decomposition of the solution of chlorid of arsenic is an example of what is called double elective affinity, (*attractio electiva duplex*,) and is generally explained by saying that the attraction of arsenic for oxygen, and that of chlorine for hydrogen, enable the chlorid and water to decompose each other. But these elemental species do not exist in the solution, although they are possible results of its decomposition, and to explain the process in this manner is to ascribe it to the affinities of yet unformed species.

I have elsewhere asserted that double decomposition always involves union followed by division,* although we cannot in every case arrest the process at the first stage. Under some changed conditions of temperature and pressure, the decomposition may be the counterpart of the previous union, and thus reproduce the original species, as in the case of mercuric oxyd, which is decomposed into mercury and oxygen at a temperature a little above that at which it was formed. When the division takes place in a sense different from the union, giving rise to new species, we have double decomposition. In the case of chlorid of arsenic, the aqueous solution exhibits the first stage of the process. A similar condition of unstable union is observed in many other instances; thus binoxyd of manganese gives with cold hydrochloric acid, a brown solution, but the combination is by a gentle heat resolved into chlorine gas, and a rose-red solution of protochlorid of manganese. So a mixture of equivalent parts of

* Consderations on the Theory of Chemical Changes, etc., cited above.

chlorid of benzoyl and benzoate of soda combines at a temperature of 130° C., to form a limpid solution, and it is only on raising the temperature that the precipitation of sea-salt indicates the commencement of that decomposition which yields at the same time anhydrous benzoic acid.* It is only when looked upon as a momentary combination followed by a decomposition, that the theory of double decomposition becomes intelligible, and in accordance with known facts.

From the narrow limits of temperature which often include the two processes, and from the ease with which light, warmth, friction and pressure excite the decomposition of such bodies as the chlorid of nitrogen, the nitrite of ammonia, the oxyds of chlorine, and the metallic fulminates, we may conceive that within still narrower limits, and under conditions as yet undefined, many bodies may exhibit affinities for each other, which are reversed by a very slight change of condition. In this way we may explain many of those obscure phenomena hitherto ascribed to *action by presence* or *catalysis*.

Montreal, Nov. 10, 1854.

Art. XIV.—*Correspondence of M. Jerome Nicklès, dated Paris, Nov.* 3, 1854.

Obituary.—The patriarch of French Botanists, M. Brisseau de Mirbel, has just died at an advanced age. For many years he had been dead to science as well as to his family and friends. He came out, like many others illustrious in science, during the French Revolution, and was active in promoting the progress of the Science of Botany at the commencement of this century. He first introduced into France the study of the microscopic anatomy of plants. The microscope which more than a century before had furnished important results to Grew and Malpighi, had long been left, in France especially, among physical apparatus, and was hardly applied to the Natural Sciences. M. de Mirbel, engaged in this fertile line of research, with very imperfect instruments, and from the commencement of his investigations in 1801, aimed to found the department of the comparative anatomy of plants, by studying for this object a number of families of acotyledonous and monocotyledonous plants.

In early youth he devoted himself with success to painting, and was intimately acquainted with the celebrated artist Girard. His knowledge of painting was afterwards of great use to him, enabling him to sketch well what he observed, as may be seen especially in his researches on the structure of the seed and embryo of different plants of the family of Labiatæ, etc.

M. Mirbel was a member of the Academy of Sciences from the year 1808. His work entitled "Eléments de Botanique" in 1815, led to his

* Gerhardt, Ann. de Ch. et de Phys. 3me Serie, tom. xxxvii, p. 299.

appointment as Professor in the Faculty of Sciences at Paris, succeeding Desfontaines. This was the first period of his scientific life. His intimate friend Duke Decaze having been named Minister of the Interior (in 1816), he accepted the position of general Secretary, which he held till 1824. If he did not publish works during this time, he performed an important service to science by using his influence in bringing back from exile men of science who had become victims of political vicissitudes at the Restoration; and through him also funds were given to the Museum of Natural History, to render the institution useful to travelling naturalists.

Returning to private life, he took up again his researches in physiology. His new labors possessed a novelty, an exactness, and perfection, which was hardly expected of a savant, who had been so long a stranger to the progress of the science. What was especially surprising, was the profound difference between his new views and those of his youth, and also his noble frankness in acknowledging any inexactness or too positive assertions in his former works. His memoirs on the development of the ovule, on the structure of the Marchantia, on the formation of the embryo, on the arrangement and mode of formation of the tissues in the stems and roots of monocotyledonous plants, on the cambium, were elaborated in this new period; and they were the occasion of spirited discussions with M. Gaudichaud, then young, whom science has lost during the present year. M. Mirbel did not long continue in this new career. He fell into imbecility, and continued in this state until his death.

Astronomical Refraction.—A memoir by M. Faye, in which he endeavors to show a defect in the existing theory of astronomical refraction and proposes a formula for correcting it, has led to an interesting discussion which has already continued two months. All the astronomers and the principal physicists have taken part. M. Biot does not adopt the innovation, and his third memoir has just been read, opposing the view that it is necessary to add to the theory the coefficient of terrestrial refraction. M. Faye has nevertheless many partisans, and the issue of the discussion does not appear doubtful.

Constitution of the Sun; Solar Magnetism.—Mr. Thomson, one of the physicists, who with Carnot, Clapeyron, Joule, Meyer and others, have most largely contributed towards establishing the relations between heat and mechanical force, has extended his researches to the heat emitted by the sun; and he observes that this heat corresponds to a development of mechanical force, which, in the space of about 100 years is equivalent to the whole active force required to produce the movement of all the planets. The author examines successively the different sources of heat, and ends by concluding that the solar heat can have no other than a meteoric origin, and that it results from the motion of meteors which fall into the sun—an idea first put forth by M. Waterston at the meeting of the British Association at Hull. Whatever may be the value of this hypothesis, we may ask whether it would not be more simple to admit that the solar heat proceeds simply from the rotatory movement of the sun; Mr. Thomson admits himself that the rotation is necessary to the production of the heat. It is known that the sun moves on its axis, and what use is this intervention of meteorites, which nothing justifies?

This idea of deriving the heat from motion, which was rejected more than thirty years ago, suggests the hypothesis which assigns an analogous origin to terrestrial and hence to planetary magnetism, an hypothesis of which we have spoken on several occasions in this Journal.* But, at that time, the question of solar magnetism was still under discussion, which, researches undertaken by M. Secchi, director of the Observatory at Rome, have now established on evidence. The sun, which is a source of heat, and a source of light, is then a source also of magnetism; heat, light, electricity and magnetism, have then a common origin—matter in motion.

Optics—Manufacture of Glass for Objectives.—In the manufacture of glass for the lenses of telescopes, the vitreous mass when brought to a liquid state in a crucible, is stirred in order to render it homogeneous, and to expel the air it may enclose. But this result is never fully attained; there are always numerous streaks in the mass, which cause the loss of a large part of the material, and hence the difficulty of obtaining lenses of large dimensions.

M. Peyronny, captain in the corps of Engineers at Cherbourg, proposes to avoid these difficulties, by giving the crucible a rapid rotatory movement around a vertical axis; the centrifugal force tends to bring all the bubbles of air about the centre of the melted mass, whilst the streaks caused by the stirring mostly disappear, and those remaining are circular and feeble, and also little objectionable if the axis of the mass be made the axis of the lens.

Polarization of the Atmosphere, &c.—There are several kinds of apparatus for exhibiting the phenomena of polarization. Besides the polariscopes of Biot, Arago, Savart, Guérard, Delezenne, Soleil, there are the polariscope of Babinet and the chromatic clock of Wheatstone: but we have not, properly speaking, an apparatus for measuring easily and rigorously the quantity of polarized light contained in a ray or in a given luminous field. M. Bernard, Professor of Physics at Bordeaux, has resolved this problem in a manner satisfactory to the most critical physicists of the Academy of Sciences of Paris, and those at the recent session of the British Association, where his apparatus was exhibited. Through the assistance of the theories of Fresnel and Arago, and also profiting by the discoveries of Babinet and Beer of Bonn, M. Bernard has constructed an instrument of extreme delicacy, which is managed with great ease, and requires but two minutes for an observation.

The same physicist has constructed a *Refractometer*, for determining, to the 4th decimal, the index of refraction of solid bodies, and for liquids arranged as a medium with sensibly parallel surfaces. He has also contrived a *universal photometer*, of which we shall give details in another communication.

Microscopes for Micrographic demonstrations, by Nachet.—Those who use the microscope in instruction, know the difficulty of adjusting in the field of vision, the objects to which they would call attention, and are aware how convenient it would be could they exhibit to several students at once, the part of an object to which attention may be directed with a needle. The microscopes of Nachet realize this object, and have been employed by Prof. Milne Edwards for a year in his lec-

* January 1854, p. 116, and November, 1854, p. 386.

tures at the Faculty of Sciences of Paris, and the Museum of Natural History. In one of these instruments, made for anatomical demonstrations, two persons may see at once the same object. The two images are formed by a prism whose transverse section is an equilateral triangle, which is placed immediately below the objective in such a way that its edge shall be perpendicular to the optic axes of the lenses. Each of the two faces of the prism reflect the image of the object at such an angle of incidence that this image passes at right angles to the surface opposed; finally the ray of light, thus turned from its direct course, meets a second prism whose surfaces are parallel to the first, but whose edges form with the edges of that a right angle. The image reversed behind the objective is thus righted by the first prism, so that the observer can direct his needles towards any part of the object without difficulty.

In other microscopes, three or even four images are obtained through as many ocular tubes, by substituting for the ordinary prism below the objective, either three reflecting prisms placed around the optical focus of the instrument, or a quadrangular prism acting as a multiplying prism. The loss of light from these additions is less than would be supposed, and Milne Edwards and other micrographers say that such instruments have been very useful in their demonstrations.

Aluminium and the Alkaline Metals.—The persevering efforts of M. H. Sainte Claire Deville and M. Bunsen, lead us to hope that aluminium will soon become a useful metal. The last advance has been made by means of the pile causing it to act on chlorid of aluminium. It is an important step; but still the process is expensive. Deville, not expecting to reach a cheaper method by means of the galvanic battery, has endeavored to use the old method by sodium, and has sought to reduce the cost of preparing this last metal. He can now prepare this metal at a cost of 25 francs the kilogramme ($2 15 cts. the pound avoirdupois.) The following is the process:—Mix together for a thousand parts,

Dried carbonate of soda,	714 parts.
Carbonate of lime,	108 "
Pulverized charcoal,	178 "

Reduce the whole to a paste with oil, and put it into an iron retort, like that of a mercury bottle. A musket barrel two decimeters long is fitted to the extremity, to which is adapted one of Donny and Mareska's receiving vessels. The retort and barrel are heated to redness: the sodium is immediately reduced, volatilizes, and is condensed in the recipient.

The only peculiarity of this process is the carbonate of lime, which serves to prevent the mixture from entering into fusion: it was through a perusal of the memoir of MM. Donny and Mareska, remarking that these chemists recommend the use of crude tartar which contains lime, that Deville was induced to study out the reason for this preference; he soon discovered it, and proved that he was right, by adding to the ordinary mixture 15 per cent. of chalk.

M. Deville has also prepared *metallic chromium*, by using the method mentioned in a preceding number of this Journal, and which depends on producing a very high temperature in an ordinary furnace. The mixture employed is oxyd of chrome and carbon, the former in slight excess. The metallic chromium resulting was of extraordinary hardness; it scratches glass like the diamond.

Manufacture of Alcohol.—The disease of the vine and the consequent dearness of wine, has directed attention to different methods of obtaining alcohol without the aid of the grape, or the cereal grains, which last the French government protects, as their use diminishes the amount of food and raises prices. Recourse has been had to the juice of the beet, which has given rise to an extensive establishment under M. Leplay, to which I alluded in a former note on the sugar of barytes. But as this use of the beet is at the expense of the sugar, and would finally turn the sugar manufactories into distilleries, we now hear of the alcohol of Indian corn, alcohol of couch grass ("chiendent"), alcohol of asphodel, which have begun to be manufactured in the colony of Algiers. Quite recently, M. Arnoult has applied to the same purpose the fact discovered by M. Braconnot of Nancy, and which consists in transforming wood into sugar by means of sulphuric acid. M. Arnoult has observed that poplar wood gives the best results, affording 79 to 80 per cent. of sugar to be converted into alcohol. The wood is reduced to coarse saw-dust then dried at 100° C; after cooling sulphuric acid is added in small portions, taking care that the material does not become heated. It is well mixed, and after repose for 12 hours, it is triturated until the mass, before almost dry, becomes quite liquid so as to run. This liquid, diluted with water, is made to boil; the acid is saturated with chalk, and the liquor after filtration is subjected to fermentation; when the alcohol is distilled off by the usual process.

The quantity of sulphuric acid employed should not be less than 110 parts for 100 by weight of the dry wood. The author hopes to diminish the quantity of acid, and is engaged at this time on this part of the process. We cannot say that the process will be economical.

Crystallizations.—We have just seen at the Sorbonne, in the laboratory of M. Dumas, a magnificent collection of artificial crystals. The principal types of crystallized compounds are represented among them, and the crystals are of high finish and transparency. Artificial crystals are usually imperfect on one side; but the author of this collection has obtained crystals that are wholly without defects. There are transparent crystals of hyposulphite of lime of perfect symmetry; of the double sulphates, monoclinic in form, of the magnesia series $SO^3RO+SO^3KO+6HO$; the different alums; the double chlorids; the different salts of copper with the fatty acids of the homologous series $C^nK^nO^4$, &c. &c. The owner of this fine collection is a German chemist, M. Stephany, who gives his time and labors wholly to this business and who devotes himself to his crystallizations with a patience quite Germanic. M. Dumas employs him in his laboratory and has given him a commission to form a collection of the principal artificial crystals—an example which should be followed. Now that crystallography has become a part of chemistry, it is indispensable that artificial products should be studied with the care which mineralogists have devoted to native crystals. The many misunderstandings will be avoided when the forms shall have been referred to types whose exact composition is known, and whose crystallized form can be verified.

This undertaking is specially interesting for scientific instruction in France, since the new programme of Chemistry which has just been prescribed to the Professors of the Faculty of Science, contains questions relating to isomorphism, polymorphism, isomeromorphism, and in general all that relates to the relations between chemical composition and crystalline form.

Introduction into France of a new species of Silkworm.—The "Société Zoologique d'Acclimatation," alluded to in a former communication,* is highly prosperous. It has made numerous laudable attempts to acclimate useful animals from different parts of the globe, and to domesticate wild animals. Although too recently formed to pronounce on the full success of its endeavors, it is already in possession of facts which give great hopes. Of these, is the acclimation of the Bombyx Cynthia ("chenille du ricin") a silkworm of India, which, according to Roxburgh, furnishes a silk so firm that clothes made of it will last a life time. The honor of having introduced this Bombyx belongs to M. Milne Edwards, the Dean of the Faculty of Sciences of Paris, who has made experiments also on the hatching of the eggs of these silkworms.

As the Ricinus (Castor-oil plant) grows with wonderful facility in the south of France and Algiers, attempts have been made for a long time to introduce the Bombyx Cynthia. But the rapidity with which the eggs hatch, and the short duration of the period of the cocoon state, has seemed to render it difficult to carry the animal from India to Europe. A series of circumstances has led to a triumph over the difficulties, and some decisive trials place the success beyond doubt. The cocoons have a russet color. At one extremity there is an opening which the caterpillar reserves in order to facilitate its escape on passing to the butterfly state. The threads of the cocoons are so agglutinated that at first it seemed impossible to divide them; but M. Guerin Menneville has succeeded in proving the dividing possible after boiling the cocoons in alkaline water. There are experiments now in progress at Algiers, to ascertain the value of the silk per acre of Ricinus compared with that of an acre of mulberry.

Industry and Agriculture of Algeria.—We cite some facts from an interesting report made by Marshall Vaillant, Minister of War, on the agricultural and industrial condition of our French colony of Algeria in 1853.

Fertility of Algeria.—In 1853, Algeria furnished to France over a million hectoliters (over three millions of bushels) of cereal grains, valued at fourteen millions of francs. It has produced the tender wheat ("blé tendre") of the best quality weighing 86 to 88 kilograms in place of 76.

Industry in Silk.—The superior quality of the Algiers silk, attested by two medals at the London exhibition and by the price it brings at Lyons, leaves no doubt that Algeria must take a prominent place among countries which derive their principal wealth from the production of silk. In 1853, three hundred and thirty-five persons ("éducateurs") have collected in the single department of Algiers 14,000 kilograms of cocoons. Plantations of mulberry are daily multiplying and the silk industry is constantly increasing.

* This Journal, vol. xvii, page 414.

Cultivation of Madder.—The madder of Algiers is known to be more highly esteemed than that of Cyprus. It follows from calculations made from several columns that the cost is 70 francs the 100 kil., while it brings 140 to 155 francs.

Cochineal.—The success of the cochineal insect at Algiers is no longer doubtful. . A hectar planted with 13,000 feet of cactus gave a crude product of 10 to 12 thousand francs of which only 2000 should be set down for expenses: there are actually 29 "nopaleries" (plantations of cactus) and 500,000 feet of cactus.

Cultivation of Cotton.—The cotton of Algiers took 11 prizes at the London Exhibition. The two varieties which grow best at Algiers are those which are of the highest price, (because America can furnish only 30,000 bales [?]) and also which give the largest return. Europeans and Arabs are engaged in the work, and during a single year the plantations of cotton have increased ten-fold.

Oils.—The olive tree in Algeria grows to the height of our largest forest trees. Certain countries, and especially Kabylia, are covered with it. Since 1852 the commerce in oil has rapidly increased. Europeans have put up well managed establishments among the mountains, and students in our nurseries from among the native population are taking lessons in grafting the olive trees. In 1853, although the product was below the mean, the amount exported was 2,914,430 kilog.

Government Nurseries.—The objects of the government nurseries are to produce a large number of young trees and give them to the colonists at a small price, and experiment on the cultivation of exotic industrial plants and endeavor to acclimate them in Algiers. To them we owe the cultivation of cotton, madder, the trades in cochineal and silk; and probably also the acclimating of the coffee and tea plants. Through them the oases have received the rice of China, which grows at the foot of the palms without requiring special care.

Value of the Forests.—The forest country of Algeria as now known, comprises about 1,200,000 hectars. Species of Cork Oak constitute a large part of these forests, and already 12,000 hectars of this wood have been explored. On the line of the Tell there are forests of cedar some of which are 4 or 5 meters in circumference; there is good timber for the construction of ships, and also other kinds, like the pine, juniper, arbor vitæ, olive, black walnut, etc., which do not yield in quality to the trees of America.

Metallurgical and Mineralogical Industry.—The exploration of the mines of copper have been active in consequence of a temporary permission of exportation given to foreigners. There were exported 3,111,516 kilog. of argentiferous lead ore. Some furnaces established within a few years produce steel rivalling that of Sweden. Quarries of marble and translucent onyx are opened which still bear marks of the labors of the Romans.

Coral Fishery.—One hundred and fifty-six vessels in the coral fishery explored in 1853 the vicinity of Bone and Calle and collected on an average 230 kilograms per boat. At the price of 60 francs per kilogram, the value of the fishery was 2,152,800 francs. Large banks have recently been discovered on the coasts of the Province of Oren.

We stop here with our citations. The rest of the Report refers especially to commerce, administration and war.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the influence of the direction of transmission upon the passage of radiant heat through crystals.*—Knoblauch has published the second portion of his very elaborate and skillful investigation of this interesting subject. We shall give his results in his own words.

I. Radiant heat penetrates certain crystals of the optically biaxial systems, like Dichroite, Topaz, Diopside, &c., in different quantities in different directions. It passes, for instance, most freely through dichroite in the direction of the middle line, less freely in a direction perpendicular to the plane of the optic axes, and least freely of all in a direction parallel to the supplementary line. In blue topaz, on the contrary, it passes in the smallest proportion in the direction of the middle line, more abundantly perpendicular to the plane of the optic axes and most freely in the direction of the supplementary line. After this transmission the rays of heat, according to their direction within the crystal, exhibit different properties in their behavior for example toward diathermanous bodies. In this particular different crystals exhibit different peculiarities

In the case of polarized heat, differences may appear for one and the same direction according to the position of the plane of polarization. Thus rays of heat whose plane of polarization coincides with the plane of the optic axes penetrate yellow and blue topaz more abundantly parallel to the middle line than those whose plane of polarization is at right angles to the plane of the axes, whereas precisely the contrary is the case in Heavy Spar, Hornblende, Pistacite, Mica, Dichroite, &c.

Rays of heat polarized in different planes often differ from each other in their capacity to penetrate diathermanous bodies after their passage through the crystal. The comparison of the rays polarized in the same sense and transmitted in the same direction exhibits the greatest variety, not only in different crystals but even in those belonging to the same species, as yellow and blue topaz, &c.

In one and the same substance, as for example mica, the quantitative as well as the qualitative differences of the rays polarized in different planes increase with the thickness of the layers penetrated.

When the heat passes successively through two plates of the same crystal, e. g. Pistacite, phenomena are observed analogous to those already mentioned according as the planes of the optic axes coincide or are crossed.

II. When the rays of heat pass through certain crystals of the optically uniaxial systems, as amethyst, idocrase, &c., quantitative as well as qualitative differences are exhibited according as the rays penetrate the crystal in one or another direction.

However great these differences are in the cases of transmission parallel and perpendicular to the axis, no difference of any kind is perceptible in the behavior of rays of heat which, whatever may be their directions, are all transmitted at right angles to the axis.

In this particular, uniaxial differ from biaxial crystals, in which the rays of heat exhibit differences in three directions at right angles to each other.

If the heat is polarized, differences are observed even in the same direction according to the position of the plane of polarization.

Transmissions perpendicular to the axis exhibit however in this case corresponding peculiarities.

It is only when the rays are transmitted along the axis that their passage and quality are independent of the position of the plane of polarization.

The differences in the penetration of the crystal in different directions are greater with polarized than with natural rays, if the plane of polarization be at one time parallel and at another perpendicular to the axis; they vanish however completely when the plane of polarization coincides with the axis. Rays of heat which have passed through amethyst and idocrase differ, under otherwise similar circumstances, with respect to their quantity and their capacity of transmission through diathermanous substances.

All these observations correspond completely with those which the author formerly made with rock crystal, beryl and tourmaline.

III. Even in crystals belonging to the regular system like colored fluor spar, blue streaked rock salt, &c., where, for instance, an arrangement in the form of layers is present, differences in the quantity as well as in the quality of the rays of heat may occur according to the direction in which they are propagated. The same is true for polarized rays. For the same direction the position of the plane of polarization has no influence.—*Pogg. Ann.*, xciii, 161, *Sept.*, 1854.

2. *On the condensation of gases by solid bodies, and on the heat disengaged in the act of absorption.*—FAVRE has studied the development of heat produced by the absorption of gases by porous solids, and has compared the quantity of heat thus set free with the latent heats of vaporization and liquefaction of the gases in question. The author first determined by means of his mercurial calorimeter the latent heats of protoxyd of nitrogen and of carbonic and sulphurous acids. He employed the same instrument to determine the heat produced by absorption and arrived at the following results. (1.) For the same gas the coefficient of absorption by carbon may vary with the kind of wood charred, and even with different specimens of the same coal. The same specimen of charcoal may present differences at different times. Heavy woods yield charcoals which absorb the least amount of gas. The gases are absorbable in the following order: ammonia, muriatic acid, sulphurous acid, protoxyd of nitrogen, carbonic acid.

(2.) The gases may be classed in the same order relatively to the amount of heat disengaged during the process of absorption to saturation. The comparison is made with equal weights of gas.

(3.) The maximum amount of heat disengaged by the absorption of 1 gramme of sulphurous acid or of protoxyd of nitrogen greatly exceeds the latent heat of liquefaction of equal weights of the same gases. Thus the latent heat of sulphurous acid is 88·3 units, while its heat of absorption is 150·1 units: the latent heat of protoxyd of nitrogen is 100·6 and its heat of absorption 148·3. In the case of carbonic acid the heat of absorption is greater than the heat of solidification, the former being 148·8 and the latter 138·7 units.

(4.) In the case of certain gases the sum of the heat disengaged, for the same weights of gas absorbed, is the same, whatever be the nature of the carbon, which in this case only affects the volume of the gas fixed in its pores. This result taken in connection with the others seems to shew that the thermic effect is not due to the liquefaction of the gas, but to some special action, since the introduction of a small quantity of gas under conditions in which we cannot suppose it to be liquefied, according to the calculations of Mitscherlich, disengages more heat than the quantity necessary for saturation. It appears possible that this action is due to the special force which Chevreul assumes and calls capillary affinity.—*Comptes Rendus*, xxxix, 929, *Oct.* 16, 1854.

3. *Researches on the Ethers.*—Berthelot has studied the action which acids when confined in close vessels exert upon the compound ethers and upon alcohol and common ether, the actions being assisted by time and by heat. The author classes his results according to three different series of facts.

(1.) Formation of the compound ethers by means of hydric ether and acids.

(2.) Direct formation of the ethers by means of alcohol and acids.

(3.) Decomposition of the ethers under the influence of water and acids.

1. When ether and different acids are heated together in strong closed tubes to a temperature of from 360° to 400° C., water is set free and a compound ether is formed. In this manner the author produced benzoic, palmitic, butyric and chlorhydric ether. When ether, butyric and sulphuric acids are distilled together, butyric ether is formed in abundance, while at the same time olefiant gas is generated. Acetic ether was formed by a precisely similar process. 2. When alcohol is heated in closed tubes with the fatty acids, which as is well known are the feeblest of the organic acids, the corresponding ethers are readily produced, although the combination is never total. In the presence of a strong acid, however, the combination is most abundant. At 100° the author produced in great abundance, after 30 hours of contact, benzoic, acetic and butyric ethers. Stearic ether was formed in very small quantity at the end of two hours, but when acetic acid was added the stearic acid was completely acidified in the same space of time. 3. In the direct formation of the ethers by the processes already indicated, neither the alcohol, ether or acid, even enter completely into combination, whatever be the respective and reciprocal excess of the reacting bodies. Berthelot attributes this with great probability to the decomposing action exerted on the ethers by the water set at liberty in the decomposition itself, the intensity of the action being augmented by the presence of acids. Thus water heated to 100° during 102 hours with stearic and oleic ethers begins to decompose them, regenerating stearic and oleic acids. At 240° and after some hours of contact, water begins to acidify benzoic ether; at the same temperature acetic ether undergoes a similar decomposition. The presence of a free acid increases the effect; thus acetic acid by a contact of six hours at 100° acidifies stearic, butyric and benzoic ethers, producing a sensible pro-

portion of acetic ether. In like manner benzoic acid at 240° produces the decomposition of acetic ether, traces of benzoic ether being formed at the same time. From this it appears that the acid which produces the decomposition may itself enter into combination with the alcohol; the phenomenon is then the replacement of one acid by another. This replacement is particularly well marked with fuming chlorhydric acid. In 106 hours at 100° this body produces the decomposition of acetic, butyric, benzoic and stearic ethers, the acids being set at liberty and chlorid of ethyl formed. The analogy between the double decompositions thus produced and the examples furnished by inorganic chemistry is sufficiently obvious.—*Ann. de Chimie et de Physique*, xli, 432, *August*, 1854.

4. *On the cyanic and cyanuric ethers and on the amids.*—WURTZ has published an elaborate and most interesting memoir on this subject, from which we shall extract those results which appear most striking and important. Cyanic ether brought in contact with water yields carbonic acid and diethyl-urea: the reaction is represented by the equation $2C_6H_5NO_2+2HO=C_{10}H_{12}N_2O_2+2CO_2$. Water of ammonia dissolves cyanic ether with disengagement of heat and formation of ethyl-urea. Thus $C_6H_5NO_2+NH_3=C_6H_8N_2O_2$. The compound ammonias exert a similar action, which the author proposes to consider in a separate memoir. Hydrate of potash and cyanic ether yield carbonate of potash and ethylamin, thus $C_6H_5NO_2+2KO, HO=2KO, CO_2+C_4H_7N$. Alcohol and cyanic ether yield *ethylurethane*, $C_{10}H_{11}NO_4$, which with caustic potash yields carbonate of potash, ethylamin and alcohol, a decomposition exactly analogous to that of ordinary urethane. With sulphuric acid ethylurethane gives ethylamin and sulphovinic acid: in its pure state it is an oily liquid boiling between 174° and 175° C. Cyanic ether and acetic acid react readily at ordinary temperatures, carbonic acid is disengaged and *ethylacetamid* is formed: the reaction is represented by the equation

$$C_4H_4O_4+C_6H_5NO_2=2CO_2+N\left\{\begin{array}{l}C_4H_5\\C_4H_3O_2\\H\end{array}\right.$$

Caustic potash decomposes ethylacetamid into ethylamin and acetate of potash. It is obvious that ethyl acetamid may be regarded as ammonia in which one equivalent of hydrogen is replaced by one of ethyl and a second equivalent of hydrogen by one of acetoxyl $C_4H_3O_2$. With anhydrous acetic acid, cyanic ether yields *ethyldiacetamid*, $N\left\{\begin{array}{l}C_4H_5\\C_4H_3O_2\\C_4H_3O_2\end{array}\right.$, in which all three equivalents of hydrogen are replaced by other radicals. Formic acid and cyanic ether give carbonic acid and *ethylformiamid*, $N\left\{\begin{array}{l}C_2HO_2\\C_4H_5\\H\end{array}\right.$

Wurtz has found in like manner that cyanic ether attacks a great number of acids, the products being amids, the constitution of which may easily be foreseen.

The constitution of cyanuric ether is represented by the formula $C_{16}H_{15}N_3O_3$, or it is isomeric with cyanic ether; it is a colorless crystalline body fusing at 95° C. The author believes that there are however other cyanuric ethers having a different constitution. Cyanate of methyl is prepared by the distillation of 2 parts of sulphomethylate of potash with 1 part of cyanate of potash. It is a light, colorless, very mobile and volatile liquid, boiling at 40°; its vapors are extremely irritating and suffocating. Its formula is C_2H_3O, CyO, and its most remarkable property is the facility with which it is transformed into cyanurate of methyl, a change which takes place spontaneously when the ether is left to itself in a closed tube. This change sometimes takes place in the course of several days, sometimes in a few minutes, and is accompanied in the last case by a sensible evolution of heat. The cyanurate of methyl is a solid crystalline body, fusing at 175°–176° and boiling at 274°. It is very remarkable that its boiling point is higher than that of the cyanurate of ethyl which is 253°. With caustic potash both these compounds of methyl yield carbonate of potash and methylamin, as the author long since shewed.

Gerhardt and Chiozza have referred the amids which contain oxygen to the type of ammonia, 1, 2 or 3 equivalents of hydrogen being replaced by 1, 2 or 3 equivalents of a radical containing oxygen. Wurtz is of opinion that this view is not applicable to all amids, and especially to those acid amids which are formed by the tribasic acids. He therefore refers these to the type of water, one equivalent of the compound NH being supposed to replace the two equivalents of oxygen in a double molecule of water. Thus the formation of acetamid is represented by the equation $\left.\begin{matrix}C_4H_3O_2\\H\end{matrix}\right\}O_2+NH_3=\left.\begin{matrix}C_4H_3O_2\\H\end{matrix}\right\}NH_2+2HO.$ For the further development of this theory we must however refer to the original memoir.—*Ann. de Chimie et de Physique*, xlii, 43, *Sept.* 1854.

5. *On some new Ethers.*—CLERMONT has studied in Wurtz' laboratory the action of iodid of ethyl upon certain salts of silver, and has obtained several interesting ethers. Iodid of ethyl heated in a closed tube with pyrophosphate of silver yields iodid of silver and pyrophosphate of ethyl. The new ether is a viscid liquid, of a burning taste and peculiar odor, soluble in water, alcohol and ether, and becoming promptly acid on exposure to moist air. Its formula is $PO_5, 2C_4H_5O$. Iodid of ethyl acts in like manner upon tribasic phosphate of silver, producing iodid of silver and the already known tribasic phosphate of ethyl, $PO_5 . 3C_4H_5O$. Carbonic ether may be produced by the action of iodid of ethyl upon carbonate of silver. It is too well known to require description.—*Comptes Rendus*, xxxix.

6. *Action of the protosalts of iron on Nitronaphtalin and Nitrobenzin.*—Under this title BÉCHAMP has published a very interesting and valuable paper on the reducing action of the acetate of protoxyd of iron upon those nitro-compounds in which an equivalent of NO_4 may be considered as replacing an equivalent of hydrogen. The author sets out from his already published observation that ordinary cotton may be reproduced from gun cotton by means of the acetate of iron. He then shews that the acetate exerts a similar action upon nitro-benzin and nitro-naphtalin, and that the products of this reaction are anilin and naphtalidin. The following processes answer for the production of these two bases in large quantities and with the greatest facility, (we

select from various methods given by the author those which he found most advantageous). For the preparation of anilin, 1 part of nitrobenzin, 1·2 parts of iron filings free from rust, and 1 part of concentrated commercial acetic acid are introduced into a capacious retort. The acetic acid must be free from mineral acid and its quantity must be sufficient to completely cover the iron. The action quickly begins without heat and becomes so violent that the liquid boils and much matter passes into the receiver, which must be well cooled. When the retort has become cool, the contents of the receiver are to be poured into it, and the whole is then to be distilled to dryness. An excess of a concentrated solution of caustic potash is to be added to the distillate; hydrated anilin separates upon the surface in a very nearly pure state. The quantity of anilin obtained by this process is almost $\frac{3}{4}$ of the nitrobenzin employed, and the author states that anilin could be prepared at 20f. the kilogramm. The process for preparing naphtalidin is similar: 1 part of nitro-naphtaline, 1·5 of iron filings, and enough acetic acid to cover the mixture completely, are employed. The action begins on applying a gentle heat so as to fuse the nitro-naphtaline; the fire must then be removed and when the violence of the action has ceased the retort placed in a sand-bath so that the belly shall be completely covered. The acetic acid distills over first; the naphtalidin comes over at 300° and condenses in an oily liquid beneath the acid which protects it from the air. The two are to be separated by a second distillation, and the naphtalidin preserved in a tightly stoppered bottle. It is remarkable that the compounds of protoxyd of iron with strong acids do not decompose the nitro compounds.—*Ann. de Chimie et de Physique*, xlii, 186, *Oct.* 1854. W. G.

7. *Prof. Tyndall on some Peculiarities of the Magnetic Field*, (Proc. Brit. Assoc., 1854, Ath., No. 1405.)—The Professor said, a piece of soft iron suspended between the flat poles of an electro-magnet set its largest dimension from pole, the residual magnetism of the cores being sufficient to produce the effect. This is the normal deportment of magnetic bodies, but it is by no means universal. By mechanical agency, by pressure for example, the structure of a magnetic body can be so modified that its shortest horizontal dimension sets from pole. Prof. Tyndall exhibited actions of the kind where the body operated on was compressed magnetic dust. In such a body two opposing tendencies were at work,—the tendency due to length, which sought to set the length axial, and the tendency due to structure, which sought to set the line perpendicular to the length axial. Between the flat poles the latter tendency was predominant, but between pointed poles this was not the case; here the attraction of the ends of the magnetic mass constituted a mechanical couple of sufficient strength to overcome the directive tendency which was due to structure, and to draw the mass into the axial line. But in raising or lowering the body operated on out of the sphere of this local attraction, by bringing it into a position where the distribution of the magnetic field resembled that existing between the flat poles, the body forsook the axial position and turned into the equatorial. The complementary phenomena were exhibited by bismuth. A normal bar of this substance sets its length at right angles to the line

from the poles; but Prof. Tyndall exhibited a bar of this substance, which set between the flat poles exactly as a magnetic body. Such a bar, however, between the points are equatorial. On raising or lowering it, however, it forsook the equatorial position and set axial. In this case the local repulsion of the ends between the points caused the bar to set equatorial, the influence of length thus predominating over the influence of structure; but removed from the sphere of this local action, the directive tendency of the mass triumphed and caused the bar to set axial. The bar in this case was cut with its length at right angles to the planes of most eminent cleavage of the bismuth:—it is a proved fact, that these planes while the influence of form is annulled, always set at right angles to the line piercing the poles, and hence where they are transverse to the length, the bar will set axial. These phenomena were examined in a great number of cases; bars were taken from substances possessing a directive tendency, and it was so arranged that the directive tendency due to structure was always opposed to the influence of length; between the points the former tendency succumbed to the latter, while between the flat poles, or above and below the points, the former was triumphant. It is amusing to observe the strife of these two tendencies in substances possessing a strong directive action. A plate of crystallized carbonate of iron, when properly suspended, will wrench itself spasmodically from one position into the other, and find rest nowhere. The simple law which governs all these actions is, that if the body, cut as above, be diamagnetic, its length sets equatorial between the points, but above and below them axial. If the body be magnetic it sets axial between the points, above and below equatorial. Hence the rotation of a magnetic body, on being removed from between the points, is always from axial to equatorial; while the corresponding rotation of a diamagnetic body is always from the equatorial to the axial. The deportment of wood in the magnetic field was next described. Nearly sixty specimens examined by Prof. Tyndall were all diamagnetic; each of them was repelled by the poles of the magnet; cubes of each when suspended with the fibre horizontal set between the excited poles, the fibre perpendicular to the line which unites the poles. Thinking that wood on account of its structure, would exhibit those directive phenomena which had been demonstrated in the case of the bodies mentioned at the commencement, bars were taken from nearly forty kinds of wood, the fibre being at right angles to the length of the bar; in the centre of the space, between two flat poles, all those bars set their length from pole to pole. But Prof. Tyndall afterwards observed the remarkable fact, that homogeneous diamagnetic bodies did the same. Bars of sulphur, of salt of hartshorn, of wax, and other diamagnetic substances, when suspended in the centre of the space between two flat poles, set their length from pole to pole. Now, as diamagnetic bodies always take up the position of weakest force, it was proved by these experiments, and corroborated by others not cited here, that the true force of the centres of two flat poles, contrary to the general opinion hitherto received, was the line of minimum force.

The Rev. Dr. Scoresby stated, that, by subjecting to force ordinary magnets of hardened steel, as by suddenly bending them, or striking them in particular modes, they may have their poles reversed or be deprived of their magnetism, or hardened non-magnetic steel may be instantly rendered magnetic; and he considered that these facts, which he had long since made public, should be kept before the mind in such investigations as the very original and interesting facts just brought under the notice of the Section.—Prof. FARADAY after very briefly, yet lucidly, explaining to the Section the leading distinctions between paramagnetic and diamagnetic bodies, and their behavior in the magnetic field, said, that it was conceded on all hands that the explanation was erroneous which Plücker had given of the phenomena which he first discovered connected with the branch of research to which Prof. Tyndall had just been directing their attention, and which he was so ably hunting down. But when he said the original explanation of Plücker was erroneous, he did not mean that as the slightest disparagement to that philosopher. It was well understood by all who had any pretensions to scientific knowledge since the days of Bacon, that it was through the mist of error that the most important discoveries had to be made, and that in pursuing any research it was much better in the first stages of the inquiry to have erroneous views, than to be without any views that would tend to connect the scattered facts. For his part, he was not ashamed to own that he was a learner, and that in almost every instance it was through the clouds of error that he arrived at the conclusions which satisfied him most. And as his mathematical skill and acquirements were by no means such as to entitle him to despise instruction, he should feel particularly grateful to his mathematieal friends present, Dr. Whewell and others, if they would explain to him and to the Section the law of distribution of the magnetic force in the magnetic field, if it was known.—Dr. WHEWELL explained how the force would be distributed upon the old theory of magnetic lines; but he said he was aware, and he believed it was now generally admitted, that this theory must be greatly modified, if not given entirely up. But as he saw Prof. W. Thomson in the Section, who had paid particular attention to the development of the mathematical theory of magnetical and electrical forces, he trusted that that gentleman would favor the Section with his views.—In answer to Prof. Faraday's question, as to the mathematical conditions under which a uniform field of magnetic force may be produced, Prof. W. THOMSON remarked, that the mathematical theory of the distribution of force afforded both a remarkably simple and definite general answer, and pointed out the most convenient practical means of fulfilling these conditions either approximately or rigorously. For, in the first place, it is strictly demonstrable that if the force be rigorously uniform in some locality, in the neighborhood of any kind of magnet or electro-magnet, through even one one-thousandth of a cubic inch, in fact, through any finite bulk however small, it cannot but be rigorously uniform through every portion of space to which it is possible to go from that locality without passing through the substance of the magnet. Hence, although between flat poles, such as Mr. Faraday first introduced for obtaining uniformity of force, we have in reality a most excellent practical approximation to a uniform distribution of very intense magnetic force, through a space of several cubic inches, in a locality not only visible, but in every way convenient for experimental purposes; yet it is absolutely impossible that the force can be rigorously uniform through the smallest finite bulk of the magnetic field in any such arrangement, or, generally, in any locality external to a magnet. If an experimenter wants a rigorously uniform field of force, he can have it only in the interior of his magnet; and he must be contented not to see the action he experiments on at the time it is being produced, unless he will follow the example of Prof. Faraday, who "went into a hollow cubical conductor of electricity and lived in it," and so was enabled to observe some most interesting and important fundamental properties of electrical force. It would be easy to make a hollow electro-magnet, in the interior of which the experimenter could observe with the minutest accuracy the bearings of all kinds and shapes of bodies in a rigorously uniform field of force. All that is necessary to make such a conductor is to take a hollow papier-mâché globe, say six feet in diameter, and roll a galvanic wire over its surface in a succession of close parallel circles, having their planes at equal distances from one another. A hollow non-magnetic body of any shape, cubical for instance, may have a rigorously uniform distribution of magnetic force produced in its interior by a suitable distribution of galvanic wire over its surface, determinable, according to the form of this surface, by the mathematical theory from which these results are stated. But it would be difficult, perhaps practically impossible, to get a sufficient intensity for exhibiting the forces experienced by diamagnetic or weakly paramagnetic bodies in a uniform field of such extent that the operator could himself enter it; and experimenters must be contented either with approximations to uniformity, such as in the arrangement with flat poles, so successfully used by Prof. Tyndall in the beautiful experiments which he had exhibited to the Section, or they must arrange to test effects in the interior of hollow electro-magnets without seeing them at the time they are taking place. Interesting questions, which the mathematical theory answers decisively, had also been asked regarding the minimum condition of the central line in a field between opposed flat poles, of two cylindrical soft-iron bar magnets, and the effects of rounding off the edges of these poles. It appears that, if we consider the intensity of the force in a plane perpendicular to the magnetic axis through the centre of the field, we find it increasing from the central point to a certain circle of maximum intensity, beyond which it diminishes gradually and falls to nothing at an infinite distance. If the edges of the cylinders be rounded off, the circle of maximum intensity contracts, its centre always being a point of minimum intensity, until a certain degree of convexity of the poles is attained, when the circle of maximum intensity becomes contracted to a point—the central point of the field—which will then be a point of maximum intensity (the central minimum being eliminated), and will continue a maximum, as regards all points in the plane through it, perpendicular to the axis, for any less flat or more prominent or pointed forms of poles. No form of rounded poles, by doing away with maximum or minimum points, can possibly give a uniform distribution of intensity through ever so small a finite bulk of the field.

II. Mineralogy and Geology.

1. *Analysis of Allophane from the Black oxyd of Copper mines of Polk County, Tennessee;* by Dr. C. T. Jackson, Assayer to the State of Massachusetts, &c.—*Description.*—This mineral occurs in the great veins of black oxyd of copper of Polk County, Tennessee, encrusting the black oxyd of copper, and is especially abundant in the mine worked by Mr. Congdon. It occurs in botryoidal and reniform concretions with a crystalline aspect somewhat resembling concretions of Prehnite in appearance.

Its color is honey yellow. Lustre resinous, particularly on fractured surfaces. It is brittle and is easily crushed to powder in an agate mortar. In a glass tube it gives off much water when heated, and the mineral becomes opaque, and is then very friable.

Before the blowpipe on charcoal becomes white and opaque, but does not melt. With soda it forms a white enamel, and effervesces in fusing. With borax forms a clear transparent glass. With salt of phosphorus it leaves a skeleton of silica of large size in the glass, but gives no color. Pulverized and placed in warm hydrochloric acid it gelatinizes readily and decomposes, leaving flakes of silica. By qualitative analysis the mineral is found to contain silica, alumina, lime, magnesia and phosphoric acid.

Quantitative analysis on 2 grammes of the mineral.—One gramme of the mineral heated to full redness in a platinum crucible, loses 0·377 gramme of water.

One gramme of the mineral that had not been ignited was decomposed by chlorohydric acid in a platinum crucible, and then the usual process of analysis for the separation of the different ingredients was pursued, and the following results were obtained:

Water,	0·377
Alumina,	0·410
Silica,	0·198
Lime,	0·005
Magnesia,	0·002
Phosphoric acid,	*traces*
	0·992

The presence of phosphoric acid was proved on the gramme of the mineral that had been ignited by digesting the mineral in chlorohydric acid, evaporating to dryness, and then dissolving in water with a little chlorohydric acid, and filtering and adding to the filtrate nitric acid, and ammonia not quite sufficient to saturate the acids, and then adding a clear solution of molybdate of ammonia. A fine yellow powder forms and subsides in the warm solution—showing the presence of phosphoric acid.

2. *On the Boracic Acid Compounds of the Tuscan Lagoons;* by Emil Bechi, (Berg- und hüttenmännische Zeitung, Oct. 18, 1854.)—Since the publication in the American Journal of Science of descriptions and analyses of some Tuscan minerals containing boracic acid, which had been described and analyzed by Prof. Meneghini and myself (as communicated to Prof. Dana by Prof. Meneghini), I have further investigated the subject with some new results interesting to mineralogical

science and illustrating the products of Tuscany. It is known that at certain places between Volterra and Siena there are springs or lagoons of hot water issuing from natural or artificially made craters, which contain a large proportion of boracic acid compounds. These Soffioni or Bulikamen, as the exhalations are called, sometimes change their place of opening, making another at some point of easier outbreak. The rock about some of the older openings has often undergone alteration and sometimes is covered with peculiar concretions. A specimen of this kind from an old lagoon of the proprietor Larderell was observed by Professor Savi and is now in the Museum at Pisa. It affords on different parts three distinct mineral species. One of them is a borate of soda, and has the following constitution:

Boracic acid.	Soda.	Water.	Lime & Magnesia.	
43·559	19·254	37·187	*trace*	$= \dot{Na}\,\dddot{B}^2 + 6\dot{H}$

The formula differs from that of borax, in having $6\dot{H}$ in place of $10\dot{H}$.

The second species is borate of lime, which afforded me

Bor. acid.	Lime.	Water.	$\dddot{Si}, \dddot{Al}, \dot{Na}$	$\dot{Mg}$
51·135	20·850	26·250	1·750	*trace* $= \dot{Ca}\,\dddot{B}^2 + 4\dot{H}$

It is probably hydroborocalcite, which differs only in containing $6\dot{H}$.

These boracic acid compounds, the borate of soda and hydroborocalcite, are very similar in physical characters and chemical relations, and may be varieties of the same species.

The third species, finally, afforded by the above mentioned specimen, has an ochre-yellow color and is crystalline. Heated it loses water and becomes black. B.B. fuses with difficulty. In chemical characters, it is a borate of iron mixed with hydroborocalcite and hydroboracite.

The existence of borate of iron in concretions at the Tuscan lagoons was remarked by Beudant in 1832. Both Dufrenoy and Dana, in their mineralogical works have mentioned these concretions under the name Lagonite, without giving an analysis or formula.

In the collections of Tuscan minerals of John Targioni, I detected an ochre-yellow mineral, which gave the tests of the iron borate; and afforded on analysis—

Boracic acid.	Sesquioxyd of iron.	Water.	$\dddot{Si}, \dddot{Al}, \dot{Ca}, \dot{Mg}$
47·955	36·260	14·016	1·769

The Lagonite therefore is no longer a hypothetical species, but one well characterised, and having the composition $\dddot{Fe}\,\dddot{B}^3 + 3\dot{H}$.

Sometime since Signor Larderell in an old lagoon, found a druse which was peculiar in its physical and chemical characters. The mineral was in yellowish-white rhombic tables of 110° 6′, and by polarised light showed a resemblance to sulphate of lime. On heating in a glass tube, a strong ammoniacal odor is given off: B.B. fuses easily to a colorless glass, which on treating with alcohol, gives a green color to the flame.

From these characters I concluded that it was a borate of ammonia, a species hitherto unnoticed, except that Erdmann in the analysis of Sassolin has reported the presence of some ammonia. Careful analysis afforded me—

Boracic acid.	Oxyd of ammonium.	Water.	
69·244	12·897	17·859	$= N\,HO^4\,\dddot{B}^4 + 4\dot{H}$

This species I have named *Larderellite*, after Sr. Larderell.* On boiling the Larderellite in water, ammonia is given out, and a new crystalline salt is obtained, having the formula $NHO^4 \dddot{B}^6 + 9\dot{H}$. Berzelius obtained by neutralizing boracic acid and ammonia, a salt crystallizing in hexagonal prisms containing according to Gmelin $NHO^4 \dddot{B}^4 + 6\dot{H}$. It differs from the Larderellite in composition and strikingly in crystalline form. It appears that one and the same salt may be obtained, with different proportions of water, by employing different temperatures; and thus is easily explained the analogy between the *borate of soda* of the lagoons and *borax*, the borate of lime and hydroborocalcite, the Larderellite and Berzelius's borate of ammonia. In the same way according to Berzelius, the sulphate of the protoxyd of manganese crystallized at the temperature of 6° R., gives the formula $\dot{Mn}\dddot{S} + 7\dot{H}$, but between 6° and 20°, the formula $\dot{Mn}\dddot{S} + 6\dot{H}$; and between 20° and and 30°, $\dot{Mn}\dddot{S} + 4\dot{H}$. The interesting point in this subject is that these compounds of manganese differ widely and irreconcilably in crystallisation, showing the influence of the water of crystallisation on the crystalline form.

Laurent takes boracic acid for monobasic—as the borate of oxyd of methyl $= C^2H^3O, BO^3 + HO, BO^3$; and the borate of oxyd of æthyl $= C^4H^5O, BO^3 + HO, BO^3$; and borax for a neutral salt, in which 1 equivalent of base is replaced by 1 of water, whence the formula of borax is

$$NaO, HO, 2BO^3 + 9HO \quad \text{or} \quad 2((\dot{Na}, \dot{H})\dddot{B}) + 9\dot{H}.$$

This view is sustained by many examples among other boracic acid compounds, which are described in Wöhler and Liebig's Annalen. Following Laurent's theory my formulas become, for the

Borate of lime,	$(\dot{Ca}, \dot{H})\dddot{B} + 3\dot{H}$
Borate of soda,	$(\dot{Na}, \dot{H})\dddot{B} + 5\dot{H}$
Larderellite,	$(NHO^4 + \dot{H})\dddot{B} + \dot{H}$

[The author closes with some observations on the condition of the boracic acid of the lagoons.]

3. *On the Thickness of the Ice of the Ancient Glaciers of North Wales, and other Points bearing on the Glaciation of the Country;* by Prof. Ramsay, (Proc. Brit. Assoc., Athen., No. 1405.)—Prof. Ramsay stated his belief that there had been two sets of glaciers in North Wales since the ground assumed its present general form. The first was on a very large scale, followed by a slow subsidence of the whole country to the extent of 2,300 feet, until only the tops of the highest hills remained uncovered by the sea; and when the mountains again rose, a set of smaller glaciers was formed. The thickness of the ice in existing Swiss glaciers was known to be very great; in the Grindelwald it had been ascertained to amount to 700 feet, and in other instances was probably thicker. The observations of Agassiz and Prof. James Forbes on the height to which grooved and polished surfaces span up the sides of Alpine valleys, had led to the conclusion, that the ice had once been much more extensive; and that in the glacier of the Aar, for example, it must have amounted to 2,000 feet. The same

* Another hydrous compound of boracic acid and ammonia I have since noticed which will hereafter be described.

method of observation had been applied to North Wales; and it had been ascertained that in the Pass of Llanberris the grooves and roundings of the rocks extended to a height of 1,300 feet above the present bottom of the valley. The drifted deposits which overlie these rounded surfaces must have formed during the slow depression which followed, and the glaciers must still have existed, since these deposits, though marine, are still of a moraine character. The cold climate continued during the period of depression, and for some time after it; and there was beautiful evidence in the side valleys of the gradual decrease of the glaciers until they died away amongst the higher mountains, in the form of moraines stretching across the valleys, one within the other. The scratches made by the first set of glaciers passed down the valleys; those of the smaller glaciers crossed the first obliquely.

4. *On the Foliation of some Metamorphic Rocks in Scotland;* by Prof. E. Forbes, (Ibid.)—It was of great importance to geologists to distinguish between lamination, cleavage, and foliation: the first resulted from original planes of deposition: the second was a superinduced structure, dividing rocks into laminæ of similar constitution, not coincident with the lines of bedding; thirdly, foliation was the division of a rock into laminæ of different mineral condition. Cleavage had been attributed, by Prof. Sedgwick, its first definer, to electrical action; by Mr. Sorby, to a mechanical force; and by Mr. D. Sharpe, to mechanical and chemical influence. The foliation of mica slate, or separation of its mineral constituents into distinct layers, had been sometimes attributed to metamorphic action on layers of different constitution; Mr. Darwin had considered it identical with cleavage, and due to the same cause,—the one passing into the other: the same view has been maintained by Mr. Sharpe. Prof. Forbes agreed with those who considered it a superinduced structure quite distinct from cleavage or lamination. The author then referred to examples of foliated structure. In a roadside quarry at Crianlarich, near the head of Loch Lomond, where the metamorphic limestone is not distorted, and exhibits distinct lines of bedding, of a pale blue color, caused by the presence of iron; also lines of different mineral matter, the laminæ frequently curved round nuclei; and dark lines of crystals of calcareous spar, produced, perhaps, by the metamorphism of bands of fossils. In the upper part of the quarry the limestone becomes foliated with mica,—the foliation being at first parallel with the bedding, then becomes wavy and contorted, is affected by small faults, and contains nuclei of calcareous spar and at length passes into a mica slate. At Ben Os there is a calciferous band in the mica slate, which, having the same strike with the Crianlarich beds, may eventually prove a guide in unravelling the structure of the country. Two miles from Inverarnon there is a bed of porphyritic trap in mica slate, and the foliation on the sides of the trap is conformable. Four miles from Inverarnon, in a quarry of trap, which sends large and small veins into the mica slate, there is evidence of a second foliation having taken place, following the small veins of trap. Near Tarbert, the mica slate is foliated and contorted; and a bed of calcareous grit cuts through it, without disturbing the relations of the curves and laminæ. In a slate quarry at Luss, the foliation accords in the main with cleavage, as observed by Mr. Sharpe, in the corresponding district; but whilst the foliation curves round the nuclei of quartz, the cleavage abuts against them.

Foliation has also been noticed in the baked rocks of Salisbury Crags. Prof. Forbes concluded, 1, that foliation was a superinduced structure; 2, that it was distinct from cleavage; 3, that it was not of mechanical origin, but a chemical phenomenon; 4, that it was, perhaps, induced by more than one agency.

5. *On the Relations of the "New Red Sandstone" of the Connecticut Valley and the Coal-bearing rocks of Eastern Virginia and North Carolina;* by Prof. W. B. Rogers, (Proc. Boston Soc. Nat. Hist., 1854, p. 14.)—Prof. W. B. Rogers exhibited a series of fossils from the middle secondary belts of North Carolina, Virginia, Pennsylvania, and Massachusetts; chiefly, he said, with the view of calling attention to the evidence afforded by some of them, of the close relation in geological age between what has been called the New Red Sandstone of the Middle States and Connecticut Valley, first designated by Prof. H. D. Rogers as the Middle Secondary Group, and the coal-bearing rocks of Eastern Virginia and North Carolina.

Prof. Rogers referred to the existence in Virginia of three distinct belts of these rocks. The most eastern of these, extending almost continuously from the Appomatox River to the Potomac, includes the coal-fields of Chesterfield and Henrico Counties. The middle tract, about twenty-five miles west by south of the preceding, is of much less extent, and has not yet furnished any workable coal seam. Somewhat intermediate in trend to these is a belt of analogous rocks in North Carolina, commencing some distance south of the Virginia line and stretching southwestwardly across the State, and for a few miles beyond its limits, into South Carolina. This area, first mapped by Prof. Mitchell, includes the coal-bearing rocks of Deep River. The western belt extends, with two considerable interruptions, entirely across Virginia, being prolonged towards the southwest in the course of the Dan River in North Carolina, and towards the northeast through Maryland, Pennsylvania, and New Jersey, forming what is usually called the New Red Sandstone Belt.

Eastern and Middle Belt of Virginia and Eastern Belt of North Carolina.—From an examination some twelve years ago of the fossil plants of the most eastern of the Virginia belts here designated, Prof. Rogers had been led to refer this group of rocks to the Oölite series on or near the horizon of the carbonaceous deposits of Whitby and Scarborough in Yorkshire. Some years later he discovered many of the same plants in the middle belt of Virginia, and, in the summer of 1850, he found several of these plants in the coal rocks of Deep River, in North Carolina. In each of the latter districts we meet with Equisetum columnare, Zamites, and a plumose plant referred to Lycopodites, and strongly resembling *L. Williamsonis* of the Yorkshire rocks. These are among the usual forms occurring in the easternmost of the Virginia belts.

Besides the fossil plants common to these three areas, they contain two species of Posidonomya and two of Cypris. Of the Cypridæ, one species has a smooth, the other a beautifully granulated carapace. They are both very small, seldom exceeding $\frac{1}{30}$ an inch in length and $\frac{1}{70}$ in width. Both species of Posidonomya differ in proportion from the *P. minuta* of the European Trias, but one of them strongly resembles the *P. Bronnii* of the Lias, although of larger dimensions.

Prof. Rogers remarked upon the uncertainty which exists as to the true nature of the small shell-like fossils, which being assumed as molluscs, have been referred to Bronn's genus Posidonomya. But, whatever may be their zoölogical affinities, the fossils now under consideration have great interest, as affording further means not only of comparing together the mesozoic belts of North Carolina and Virginia, above referred to, but of approximating more justly than heretofore to the age of the so-called New Red Sandstone, or Triassic rocks which form the prolonged belt lying further towards the west.

In the report of Prof. Emmons, published in the autumn of 1852, mention is made of the remains of Saurians in the Deep River deposits, as well as of the Posidonia and Cypris, and of an Equisetites, a Lycopodites and other allied forms, together with a naked, rather spinous vegetable, regarded by him as a cellular cryptogamous plant.

In view of the general identity of the fossils thus far found in the Dry River and Middle Virginia belts, with those of the most eastern deposit in Virginia, viz., that including the coal of Chesterfield, Prof. Rogers maintained that the general equivalency of these three areas may be regarded as established, and therefore the Dry River belt of North Carolina, as well as the Middle Virginia belt, ought to be placed in the Jurasic series, not far probably above its base.

Western Belt of North Carolina and Virginia and its Extension towards the Northeast, forming the so-called New Red Sandstone of Virginia, Pennsylvania and New Jersey, and probably of the Valley of the Connecticut.—In North Carolina, on the Dan River, where the rocks include one or more thin seams of coal, the same Cypridæ or Posidoniæ are found in great numbers in some of the fine-grained shales and black fossil slates. The latter were noticed as early as 1839, by Dr. G. W. Boyd, while on the Virginia Geological Survey. Regarding this fossil, of which specimens were also obtained about the same time from the middle belt in Virginia, as identical with the Posidonia of the Keuper, Prof. Rogers had, many years ago, announced the probability that a part or all of the great western belt was of the age of the Trias, instead of being lower in the Mesozoic series.

Specimens of the Posidoniæ and Cypridæ, from both belts in North Carolina, and from the eastern and middle belts in Virginia, were exhibited by Prof. Rogers at the Albany meeting of the American Association of Science, in 1851, for the purpose of showing the close relationship between these deposits, in geological time. Among the specimens from the Dan River, Prof. Rogers on the present occasion referred to the impression of a Zamite leaf and a joint of Equisetum columnare. Prof. Emmons, in the report above referred to, speaking of the marly slate of this system, says that "it differs in no respect from that of Deep River, bearing the same fossils, Posidonia and Cypris, in great abundance."

In the belt in Virginia, toward the Potomac river, Prof. Rogers had lately found immense numbers of the same Posidonia and Cypridæ, crowded together in fine argillaceous shales, and at several points he had met, in the more sandy rocks, vegetable impressions, which, although obscure, are strongly suggestive of the leaves of Zamites.

In the same belt in Pennsylvania, in the vicinity of Phœnixville, early last spring, Prof. H. D. Rogers discovered Posidoniæ in great numbers in a fissile black slate, and on subsequent examination, the same beds were found to contain layers crowded with the casts of Cypridæ. Along with these are multitudes of Coprolites, apparently Saurian, resembling in size and form the Coprolites found in the carbonaceous beds on Deep River, and also some imperfect impressions of Zamites leaves. These facts Prof. Rogers considers sufficient to identify, as one formation, the disconnected tracts of this belt in North Carolina and Virginia, and the great, prolonged area of the so-called New Red Sandstone of Maryland, Pennsylvania, and New Jersey.

As to the geological date of this belt, Prof. Rogers said that the discovery at various and remote points of its course of Posidoniæ, Cypridæ, and Zamites, most or all of which are identical with these forms in the eastern middle secondary areas of Virginia and North Carolina, makes it extremely probable that these rocks, formerly referred to the New Red Sandstone, and of late more specially to the Trias, are of Jurassic date, and but little anterior to that of the Coal Rocks of Eastern Virginia.

Prof. Rogers considered the frequent occurrence of Cypridæ in all these belts as a strong evidence of their Jurassic age. While only a few species of Cypridæ, and many of the allied genus Cytherina occur in the Silurian and Carboniferous rocks, there is a total absence of these crustacean remains throughout the series of deposits extending from the base of the Permian to the lower limits of the Oölite. But on entering the latter, the Cypridæ re-appear, and become very abundant there, there being no less than twelve species known to belong to the Oölite formations of Europe.

On comparing the silicified wood, found in the western and eastern belts, Prof. Rogers had found its structure to be the same, and to agree very nearly with the fossils figured by Witham under the name of Peuce Huttonia. As this particular structure does not appear to have been met with below the Lias, and occurs in that formation, it furnishes another argument in favor of the Jurassic age of all these rocks.

Prof. Rogers added, that he had not found in the New Red Sandstone of the Connecticut Valley either the Posidonia or Cypris, although he had met with obscure markings which he was inclined to refer to the latter. He had however satisfied himself that one of the plants, from the vicinity of Greenfield, in Massachusetts, was identical with the form in the Virginia coal rocks referred to Lycopodites, and probably *L. Williamsonis;* and that among the other very imperfect impressions associated with this, was one which he regarded as the leaf of a Zamites.

On the whole, therefore, Prof. Rogers concluded that the additional fossils from the coal-bearing rocks of Virginia and North Carolina served to confirm the conclusion of their being of Jurassic date, and that the fossils, thus far found in the more western belt, and its extension through Pennsylvania and New Jersey, rendered it proper to remove it from the Trias and place it also in the Jurassic period, a little lower probably than the eastern belt of North Carolina and Virginia; and there could be little doubt, he thought, that the same conclusion would apply to the New Red Sandstone of the Connecticut Valley.

6. *Note on an indication of depth of Primeval Seas, afforded by the remains of color in Fossil Testacea;* by EDWARD FORBES, F.R.S., Pres. G. S., (Proc. Roy. Soc., March, 1854.)—When engaged in the investigation of the bathymetrical distribution of existing mollusks, the author found that not only did the color of their shells cease to be strongly marked at considerable depths, but also that well-defined patterns were, with very few and slight exceptions, presented only by testacea inhabiting the littoral, circumlittoral and median zones. In the Mediterranean only one in eighteen of the shells taken from below 100 fathoms exhibited any markings of color, and even the few that did so, were questionable inhabitants of those depths. Between 35 and 55 fathoms, the proportion of marked to plain shells was rather less than one in three, and between the sea-margin and 2 fathoms the striped or mottled species exceeded one-half of the total number.

In our own seas the author observes that testacea taken from below 100 fathoms, even when they were individuals of species vividly striped or banded in shallower zones, are quite white or colorless. Between 60 and 80 fathoms, striping and banding are rarely presented by our shells, especially in the northern provinces; and from 50 fathoms shallow-wards, colors and patterns are well marked.

The relation of these arrangements of color to the degrees of light penetrating the different zones of depth, is a subject well worthy of minute inquiry, and has not yet been investigated by natural philosophers.

The purpose in this brief notice is not, however, to pursue this kind of research, but to put on record an application of our knowledge of the fact that vivid patterns are not presented by testacea living below certain depths, to the indication of the depth, within certain limits, of palæozoic seas, through an examination of the traces of color afforded by fossil remains of testacea.

Although their original color is very rarely exhibited by fossil shells, occasionally we meet with specimens, in which, owing probably to organic differences in the minute structure of the colored and colorless portions of the shell, the pattern of the original painting is clearly distinguished from the ground tint. Not a few examples are found in mesozoic as well as in tertiary strata, but in all the instances on record, the association of species, mostly closely allied to existing types, and the habits of the animals of the genera to which they belong, are such as to prevent our having much difficulty about ascertaining the probable bathymetrical zone of the sea in which they lived.

But in palæozoic strata the general assemblage of articulate, molluscan and radiate forms is so different from any now existing with which we can compare it, and so few species of generic types still remaining are presented for our guidance, that in many instances we can scarcely venture to infer with safety the original bathymetrical zone of a deposit from its fossil contents. Consequently any fact that will help us in elucidating this point becomes of considerable importance.

Traces of coloring are rarely presented by palæozoic fossils, and the author knows of few examples in which they have been noticed. Professor Phillips, in his 'Geology of Yorkshire,' represents the carboniferous species, *Pleurotomaria flammigera* (i. e. *carinata*) and *conica*, as marked with color, and Sowerby has figured such markings in *P. carinata* and *P. rotundata*. In the excellent monograph of the carboniferous fossils of Belgium, by Professor De Koninck of Liège, indications of pattern-coloring are faintly shown in the figures of *Solarium pentangulatum*, and distinctly in those of *Pleurotomaria carinata* and *Patella solaris*.

In the cabinets of the Geological Survey of Great Britain are some finely-preserved fossils from the carboniferous limestone of Parkhill, near Longnor in Derbyshire. Among these are several that present unmistakable pattern-markings, evidently derived from the original coloring. They are—

Pleurotomaria carinata and *conica*, showing wavy blotches, resembling the coloring of many recent *Trochidæ*.

An undescribed *Trochus*, showing a spiral band of color.

Metoptoma pileus, and

Patella? retrorsa, both with radiating stripes, such as are presented by numerous existing *Patellidæ*.

Natica plicistria, with broad mottled bands.

Aviculo-pecten, a large unnamed species, with spotty markings on the ribs in the manner of many existing *Pectines*.

Aviculo-pecten sublobatus, Ph.? Beautifully marked with radiating, well-defined stripes, varying in each individual, and resembling the patterns presented by those recent *Aviculæ* that inhabit shallows and moderate depths.

Aviculo-pecten intercostatus and *elongatus* also exhibit markings.

Spirifer decorus and *Orthis resupinata*, show fine radiating white lines.

Terebratula hastata, with radiating stripes.

The analogy of any existing forms that can be compared with those enumerated, would lead to the conclusion that the markings in these instances are characteristic of mollusks living in less depth of water than 50 fathoms. In the case of the *Terebratula*, which belongs to a genus the majority of whose living representatives inhabit deep water, it may be noticed that all the living species exhibiting striped shells are exceptions to the rule, and come from shallow water.

There are many circumstances which warrant us to suspect that the carboniferous mountain limestone of most regions was a deposit in shallow water. The facts now adduced materially strengthen this inference.

In the British Museum there is a beautifully spotted example of a Devonian *Terebratula*, brought by Sir John Richardson from Boreal America.

Specimens of the *Turbo rupestris*, from the Lower Silurian Limestone of the Chair of Kildare near Dublin, exhibit appearances that seem to indicate spiral bands of color.

7. *Arsenate of Lead and Vanadate of Lead.*—Beautiful specimens of these two minerals have been detected by Dr. J. Lawrence Smith among the minerals coming from the Wheatley Mine near Phœnixville, Penn. A full description of them will be given in his next paper on the reëxamination of American minerals.

8. *On the Identity of Ripidolite of von Kobell with Clinochlore;* by N. von Kokscharov.—M. N. von Kokscharov has sent us an elaborate paper on the Clinochlore of Achmatowsk and its identity with Ripidolite, which is crowded out of this number and will appear in our next.

III. Botany and Zoology.

1. *Martius, Flora Brasiliensis:* fasc. XII. Dec., 1853. (folio.)—This part of Professor Martius's elaborate Flora of Brazil, which has been long in reaching us, comprises the *Urticineæ*, which are elaborated by Prof. Miquel of Amsterdam, who had already published an excellent and much-needed monograph of the Fig tribe. We are pleased to see that a botanist so thoroughly acquainted with Urticineous plants, and of such sound judgment, does not regard them as a group of orders, but as constituting one large and polymorphous order; the *Urticineæ* in his view being even more extensive than the *Urticeæ* of Jussieu, inasmuch as he takes in the *Ulmeæ* also. Different as the types of the several included groups are, yet they are so intimately connected by every kind of intermediate form that, in Prof. Miquel's opinion, they are not to be definitely separated. His *Urticineæ* accordingly embrace four suborders, viz.,—the *Artocarpeæ* (including *Moreæ*), the *Ulmaceæ*, the *Urticeæ*, and the *Cannabineæ*. All but the last of these are of course represented in the Brazilian flora; the *Artocarpeæ* by 16 genera and a large number of species; the *Ulmaceæ* by *Celtis* and *Sponia;* and the *Urticineæ* by 6 genera. The descriptions are illustrated by 45 elaborate folio plates. A. G.

2. *The non-assimilation of Nitrogen by Plants.*—M. Boussingault has published, in the *Annales des Sciences Naturelles*, 4th ser., tom. i, No. 4 and 5, the details of an interesting and well-devised investigation upon the vegetation of several plants, of different families, from which ammonia and all azotized organic matter were excluded; and he finds that under these conditions there is no more nitrogen in the resulting vegetation than there was in the seed, but usually a considerable loss of this element; showing that the nitrogen of the atmosphere is not assimilated by plants in such cases. Another memoir is promised illustrating the conditions under which this element is assimilated when plants are grown in a sterile soil in the open air. A. G.

3. *Lupulin.*—The corpuscles on the bracts and ovaries of the Hop, to which hops owe their essential qualities, have lately been studied, both structurally and chemically, by M. Personne. Their development is explained in the Ann. Sci. Nat., ser. 4, tom. i, No. 5, and illustrated by fine figures drawn by M. Trécul. The corpuscles are of the nature of epidermal glands, of a cup-shaped or saucer-shaped form, the cells of which secrete a yellow liquid, which at length distends the gland, and elevates the cuticle of the upper surface into a form resembling the acorn surrounded below by its cup. The account of these corpuscles given by Raspail appears to have little more foundation in fact than his hypothesis that they are analogous to pollen. A. G.

4. *The Fertilization of Ferns.*—The most important fact in respect to the fertilization of the higher Cryptogamia, which has been brought to light since the publication of Mr. Henfrey's Report on the subject, (reproduced in this Journal, vol. xiv,) has just been furnished by Hofmeister. Suminski, indeed, who discovered the two kinds of organs on the prothallia, or seed-leaves of germinating Ferns, affirmed that he had seen the moving spiral filaments, or spermatozoids, of the anthe-

ridia enter the canal of the archegonia (called by him ovules); but his observations were not thought altogether trustworthy in this and in some other particulars. But Hofmeister, one of the ablest vegetable anatomists, and the most experienced and trustworthy in this kind of investigation, has recently announced (in Proceedings of the Royal Society of Sciences of Saxony, April 22, 1854) that he has seen the moving spermatozoids, not only in the canal of the archegonium of Ferns, but even (in three instances) in the cavity of its central cell, in which the germinal vesicle originates, "actively moving about the germinal vesicle, which is adherent to the vaulted apex of the central cell near the inner extremity of the canal, with its hemispherical free end hanging down in the cavity. In one case where these spermatozoids had arrived at the central cell of an archegonium of *Aspidium Filix-Mas*, the movements lasted for seven minutes from the commencement of the observation. The cessation was accompanied (and probably caused) by the coagulation of the albuminous substance of the fluid contents of the central cell." (Henfrey's transl. in Ann. and Mag. Nat. Hist., No. 82.) In several instances he has seen motionless spermatozoids, lying by the side of the partially developed germinal vesicle. A. G.

5. *Botanical Necrology.*—The year now closing has been a fatal one to an unusual number of scientific men, and especially to botanists. In addition to those mentioned in the last number of this Journal, namely, Dr. Fischer, M. Moricand, and Mr. Webb, we have now to lament the decease of Mr. Winterbottom and Dr. Stocks, two English botanists, who had made extensive collections in different parts of India, and had returned home to elaborate their ample materials. Also of G. W. Bischoff, Professor of Botany in the University of Heidelberg, a voluminous author, especially of works upon terminology, &c., and an admirable draughtsman. He died of apoplexy on the 11th of September; aged about 60 years. To the list must be added the more celebrated name of M. Mirbel, one of the most distinguished vegetable anatomists of the age. His earliest publications bear the date of 1801; his latest memoir, on the embryology of Pinus (in which M. Spach was associated with him,) was read before the Academy of Sciences in the autumn of 1843. He shortly afterwards retired from his professorship at the *Jardin des Plantes*, on account of enfeebled health, and has continued with his mind totally prostrated by disease until his death, on the 13th of September. He was one of the luminaries of a past generation. A comparison of his *Traité d'Anatomie et de Physiologie Végétales*, and his *Elèmens de Physiologie Végétales et de Botanique*, with the similar treatises of the present day, will well show the progress that has been made in the science during the first half of the nineteenth century. A. G.

6. *Payer; Traité d'Organogénie Végétale Comparée*, livr. 1–4. Imp. 8vo. Paris: Victor Masson, 1854.—This elaborate work is to form two volumes of letter-press, and an Atlas of 150 plates, of the same imperial 8vo. size. It is issued in monthly numbers, each of about 48 pages of letter-press and 9 or 10 plates. The latter are crowded with admirable details, each having 30 or 40 separate figures. The organogeny of each natural order of plants is treated in succession, and illustrated by details from one or more genera; the figures exhib-

iting the whole development of the principal organs of the blossom, from their earliest appearance to the completed flower-bud. Such investigations are of high importance; although they are not likely to modify very materially views soundly based upon comparison of floral characters. Still they often furnish data for elucidating obscure points of botanical affinity or morphology, or a decisive test of the correctness of an ingenious hypothesis;—data which M. Payer sometimes turns to good account, although he cannot be said thus far to evince any remarkable aptitude for the discussion of such questions. We notice here and there points brought forward as new which have been elsewhere published for some time. A. G.

7. *The Micrographic Dictionary;* by GRIFFITH and HENFREY. (Van Voorst, London.)—Parts III, IV, and V, have reached us since our last notice of this valuable work: the latter ending, on page 128, with the article Ceruminous glands. The articles which strike us as most interesting and important are those upon *Angular aperture*, *Blood*, *Bone* (which is admirably illustrated), and the *Cell*, especially that on the Vegetable cell. A. G.

8. *The Individual in Plants, in its relation to Species*, is the title of a recent Memoir by Professor Braun of Berlin, of so much general interest, and so ably handled, that we hope we may be able to publish a copious abstract of it in a future number of this Journal. A. G.

9. *On the Influence of the Solar Radiations on the Vital Powers of Plants growing under different Atmospheric Conditions;* by J. H. GLADSTONE, (Proc. Brit. Assoc., Athen., No. 1405.)—This was the second Report given by the author under the same title, and commenced by describing accurately what portions of the prismatic spectrum were cut off by the various colored glasses employed in his experiments. A series of observations followed on hyacinths grown under very varied influences of light, and solar heat, and chemical agency. Among the results may be mentioned the power of the yellow ray to diminish the growth of rootlets, and the absorption of water; the power of the red ray to hinder the proper development of the plant; and the effect of total darkness in causing a rapid and abundant growth of thin rootlets, in preventing the formation of the green coloring matter, but not of that of the blue flower, nor of the other constituents of a healthy plant. A series of experiments on germination was then detailed. Wheat and peas had been grown without soil under large colorless, blue, red, yellow, obscured colorless, and obscured yellow glasses, and in perfect darkness. The effects resulting from these varied conditions were very marked; and the description of them occupies a considerable space in the Report. The two plants experimented on—being chosen from the two great botanical divisions—exhibited a wide diversity, sometimes amounting to a direct opposition, in their manner of being affected by the same solar ray; but in the case of both the plants, under the circumstances of the experiment, the following effects were observed:—The cutting off of the chemical ray facilitates the process of germination, and that both in reference to the protrusion of the radicles, and the evolution of the plume: the stem grows unnaturally tall, and there is a poor development of leaves in darkness, becoming more manifest as the darkness is more complete;

and the yellow ray exerts a repellant influence on the roots, giving the wheat a downward and the pea roots a lateral impulse. A few experiments on the germination of other seeds were then narrated; and the Report concluded with an account of experiments on the germination of wheat and peas in oxygen, hydrogen, and carbonic acid gases, as well as in ordinary atmospheric air, and in air from which carbonic acid was at all times certain to be removed. The results confirmed former observations on the necessity of oxygen.

Prof. MILLER, in thanking the author for his valuable researches, made some remarks on the interesting results that the investigation had brought to light; and drew especial attention to the remarkable fact stated in the paper, that the blue rays retarded the action of germination at first, although they probably accelerated the growth of the plant afterwards,—the act of germination being attended with the absorption of oxygen, but the process of development being, on the contrary, attended with the extrication of this gas.—Professor ANDERSON remarked, that a similar difference in the rate of growth of the leguminous plants and grasses to that described by Mr. Gladstone had been observed when they were manured with the same material. Nitrate of soda, which was found to be an excellent fertilizer for grasses, had comparatively little iufluence upon leguminous plants.

10. *Note on the Mastodon* (?), *and the Elephas primigenius;* by Sir JOHN RICHARDSON.*—*Mastodon* (?)—At page 102 of the Zoology of the Voyage of H. M. S. Herald, it is stated that the scapula of the Mastodon does not exhibit the remarkable depression which characterises the fragmentary shoulder-bones found at Swan River. Since I have (through the kindness of the author) had an opportunity of consulting Dr. Warren's excellent work on the *Mastodon giganteus*,† I have discovered this assertion to be erroneous; a depression in the same part of the shoulder-blade of that species being noticed in the text by that gentleman, and figured in his large plate. The probability therefore is that the Swan River bones belonged to the *Mastodon giganteus*, and that the range of that species must be extended northwards in Rupert's land to the fifty-second parallel of latitude, while the provisional geographical designation of Elephas Rupertianus must be expunged.

The depression in question was most likely designed to afford a firmer attachment to the central fasciculæ of the *infra spinatus* muscle; and a similar one, though not so sharply defined, exists in the scapula of an Indian fossil elephant from the Seewalik hills, deposited by Dr. Falconer, in the British Museum, as noticed at p. 102; but it is totally wanting in the several scapulæ of the Eschscholtz Bay elephants which are preserved in the British Museum and Haslar Hospital, the part in question being in them smooth and convex.

The error of my former notice above alluded to, arose from an inspection of Mr. Koch's skeleton of the Mastodon now in the British Museum, whose shoulder bones exhibit no such depression. Neither is this character visible in two other scapulæ purchased by the same institution from Mr. Koch as bones of the Mastodon; all the four scapulæ having merely some roughness, but no hollow, in that part of the

* From a communication made by Sir John Richardson to Dr. John C. Warren, from whom the above was received for this Journal.

† Description of the *Mastodon giganteus*, by John C. Warren, M.D., Boston, 1852.

infra spinal surface. From this fact one might be led to conclude that the concavity in question is merely an individual peculiarity, and does not occur generally in the species; but it is rare to meet a mere osteological variety so perfectly alike in form in the two limbs as it is in our Swan River scapulæ, and, as we presume it to be, in both shoulder-blades of Dr. Warren's Newburgh Mastodon; for had it been otherwise, that accurate observer would have mentioned it. And the matter admits of another explanation.

Mr. Koch's skeleton, when first brought from America for exhibition in this country, had its parts not only misplaced, but composed of the bones of more than one individual, there being at least five vertebræ too many in the spine. It may therefore be, that the two scapulæ now forming part of the skeleton of the British Museum Mastodon, and the two detached ones, are in reality bones of the American fossil Elephant, of which a cranium of great size was purchased by the Museum from Mr. Koch. Dr. Warren has shown that the *Mastodon giganteus* and the great fossil Elephant were coeval (op. cit. p. 142); and Mr. Koch may have dug up the remains of both animals from the same deposit. Not the least doubt rests on the authenticity of every part of Dr. Warren's skeleton of the Mastodon,—the account of its discovery and disinterment being quite clear.

The Swan River scapulæ belonged to an individual of intermediate size, between the Cambridge (Mass.) Mastodon and Dr. Warren's.

Elephas Primigenius.—Very recently a fossil skeleton of an Elephant has been discovered by Mr. Roderick Campbell, of the Hudson's Bay Company, on the sixty-first parallel of latitude, on the west side of the Rocky Mountain chain, near the sources of the Yukon or Kwichpack, at an elevation by calculation of considerably more than 1500 feet above the ocean. The skeleton, when first found, was believed to be entire, but unfortunately, the Indians employed to disengage it and bring it home to the Fur Post let it slip into a deep lake, where it now lies, with the exception of a tibia, which was recovered and brought to this country. This bone is of a bluish-white color, has lost some of the rotular surface immediately beneath the knee-joint, and portions of the surface on its rotular and lateral aspects have scaled off; it is otherwise very perfect, the articulating surfaces of the knee and ankle joint being especially in good condition.

On comparing the Yukon fossils with the smaller but more perfect *tibia* brought from Eschscholtz Bay by Captain Beechey, and now in the British Museum,* the popliteal aspects and distal articular surfaces are alike in both, as were also the peroneal and medial aspects; though in this case the comparison is less satisfactory, from the surface having partly scaled off in the Yukon fossil. The circumferences of the proximal articulations are not perfect in either bone, but the parts which remain present no dissimilarities.

Dimensions of tibiæ (by calipers.)

	From Yukon.	Esch. Bay.
Length of the medial face of the shin bone from the brim of the knee-joint to that of the ankle bone, ...	26·1 in.	18·8 in.
Length of the fibular face from the brim of the knee-joint to the proximal edge of the articular surface on which the distal extremity of the fibular moves, ...	23·1 in.	15·8 in.

* Numbered 82–2 and 31A in the Catalogue of the British Museum.

11. *Remains of the Mammoth and Mastodon in California;* by W. P. Blake.—A large tooth of the Elephas primigenius was found about a year since on the shores of the Bay of San Pedro (the sea-port of Los Angelos) California.* It was washed out of a bank by the undermining action of the surf. This bank contains an abundance of shells of species apparently identical with those now living on the coast.

The tooth is in excellent preservation; the grinding surface retaining its polish as perfectly as if it had been but recently taken from the jaw. This grinding surface is five and a half inches long, and exposes the ends of eight plates. The whole length of the tooth is twelve inches.

It is reported that other teeth, together with portions of the skeleton, have recently been found in the earth several miles inland from the Bay, in the direction of Los Angelos.

During my recent visit to the mining region of the State, I ascertained that teeth of both the Elephas primigenius and the Mastodon, had been exhumed at several places from the auriferous flats.

In Calaveras county, at the mining town called Murphy's, several teeth of the Mastodon have been taken out from a depth of about thirty feet below the surface. They were imbedded in blue clay, and associated with auriferous gravel and fragments of talcose slates. Two of the teeth have been preserved, and I was permitted to make drawings of them.

I conversed with a miner at this town, who had found what he supposed was a number of teeth connected together. His partners being anxious to have a specimen to send home, the mass was "split up" and a tooth given to each owner in the claim. This specimen was undoubtedly a tooth of the Mammoth, and the plates were mistaken for single teeth.

A large tusk was taken out of Texas flat about two years ago. It was allowed to remain exposed to the weather outside of a miner's cabin, until it fell to pieces and crumbled away. Many interesting specimens share a similar fate; or they are hoarded up by persons who fancy they have an extraordinary value, and who will hardly part with them at any price.

12. *Discovery of Viviparous Fish in Louisiana;* by B. Dowler, M.D., (from the N. O. Med. and Surg. Journal.)—In the month of October, 1854, through the politeness of J. C. B. Harvey, M.D., of Tchoupitoulas street, I received a small osseous fish, caught in the New Orleans Canal, which connects the city with Lake Pontchartrain. This fish had been placed in a basket containing crabs, one of which wounded it slightly in the abdomen near the cloaca, thereby exposing several fœtal fish enveloped in a delicate membrance. The parent fish, which had been rudely thrust into a narrow-mouthed phial of spirits, retains after immersion for two weeks, the original *rigor mortis*, and the same remark applies to the fœtuses, though they have been soaked in water: some of them have been forcibly straightened. On the 17th of October, in the presence of, and assisted by Dr.'s J. Hale and M. M. Dowler, I enlarged the wound and proceeded to dissect a somewhat globular mass of fœtuses bounded by the intestines before, and separated from

* The specimen was found by a brother of Capt. Ord, U. S. A., from whom I procured the specimen for description.

them by an indescribably thin, diaphanous membrane; this mass was further bounded above by the spine and ribs, below and behind by the posterior inferior abdominal walls, bulging backward of the anal orifice and fin. The exterior envelop of this oblong globe consisted of a very thin, pelucid, extremely delicate and apparently laminated and flocculent membrane, like the amnion of the human embryo in the early state; it did not form a simple sack, but consisted of many duplications like the arachnoidal reflections among the sinuosities and convolutions of the human brain, sending its prolongations as the hyaloid membrane does, through the vitreous mass of the eye.

This uterine membrane (ovisac it may not be termed) contained twenty-two fishes. It is probable that the inner surface of the uterine membrane sent forth a still more delicate membrane which enveloped each fish after the manner that the peritoneum envelops the abdominal viscera; but the parent fish, and still more its inclosed organs, were too minute to admit of full demonstration during a necessarily hurried examination; moreover the wish not to mutilate the parent fish very much prevented a fuller dissection of the fœtal mass *in situ*.

Each fœtal fish was doubled laterally, sometimes to the right, sometimes to the left into the globular form, the caudal fin which is inclined to the lancet shape, though blunter, overlapped one eye and one side of the mouth; each fish *in situ*, and even after forcible extraction from its bed was infolded in a sack; some were drawn out united by pedicles to a common stem, somewhat like an umbilical cord.

These fœtal fishes presented a perfect example of close packing. A perceptible force was required to dislodge them from their beds. The concavity left by their extraction appeared to be lined with a smooth, black, peritoneal membrane.

The intestines which were very minute were crowded forward by the rounded mass of fœtuses which occupied the greater portion of the abdominal cavity. No ova were discovered.

The maternal fish not being much mutilated, is reserved for a more detailed technical description, which my leisure and the limits of this Journal will not admit of at present.

Without attempting fully to describe even the dermal skeleton, I may observe that this tiny fish is a most symmetrical one. Its minuteness may be imagined when I state that after the removal of the inclosed fœtuses it weighed only seven grains, though not disemboweled. Thorough desiccation would probably reduce its weight one half or more. The fish exposed for two hours in the shade on a damp day, was but slightly desiccated. It was weighed by Mr. Macpherson, apothecary, in my presence; but fearing a mistake I had it weighed the second time, with the same result. If each fœtus should weigh but one grain, the aggregate would be more than three times greater than that of the mother.

Measurements in inches: Length including the caudal fin 2 inches; greatest circumference $1\frac{3}{4}$; width vertically $\frac{1}{2}$; length of thoracic fin $\frac{1}{4}$; the caudal fin does not expand from its base or proximal end, but terminates ovally, its length $\frac{1}{2}$; the anal but little expanded $\frac{1}{4}$; the ventral is too minute for convenient measurement, being almost invisible without a lens; the dorsal which is single, has but a slight vertical width, arising from a base $\frac{1}{4}$ of an inch, nearly opposite, though a little forward of the anal.

The teeth are advanced, nearly ranging with the lips, being very numerous, close and small, though scarcely discernible without a magnifying glass. Lips thin, the under one slightly projecting; angles of the mouth not depressed; eyes medium size; head flattened at the frontal bone; operculum much expanded. The branchiæ largely developed in three great arches, densely fringed with thick tufts, the outer and inner rows inclining to the central, having also, one, perhaps more rows behind, which are shorter.

The predominant hue of this fish is a tawny or fawn color; the opercula silvery; head metallic gray; muzzle blackish, slightly projecting.

There are six rows of rather quadrangular black spots, more particularly marked in the posterior half of the body, averaging twenty-five spots for each row. These black spots, resting on a tawny ground, leaving intervals something larger than themselves, give a picturesque appearance, forming stripes of alternating hues, the three upper of which slightly curve corresponding to the arching back; but each becomes straighter, the fourth and fifth being nearly straight; the sixth or lower row follows the abdominal curve, and disappears at the anal fin; the other five rows gradually converge without coalescing at the origin of the caudal fin. At the origin of this fin the spots are displaced out of a line. By this arrangement the six rows of alternating black and tawny leave in the longitudinal direction six other continuous tawny stripes, all of which except the two interrupted ones, lost at the anal fin, converge without mingling in the tail, all being about equal in length. The colors fade somewhat into a greyish yellow around the thoracic fins, which are nearly central between the dorsum and abdomen, being on a level with the eyes, and about one line from the opercula.

There are six or seven rows of scales. The spinous rays of the fins are about twenty-five caudal, twelve anal, fifteen dorsal, ten thoracic.

The fœtuses are half an inch long, all alike, exactly resembling the maternal form and proportion, with the following slight exceptions, namely: their bodies are more slender and compressed laterally; their heads are comparatively larger, and their eyes more prominent; their colors are less variegated, and paler; a still greater difference appears about the middle of the abdomen, where there is attached to each fœtus a whitish, faintly yellowish, placental-like irregularly formed mass of considerable size, having a broad base, being apparently implanted in or blended with the abdominal intergument, possessing considerable strength and constituting what may be termed the umbilical prominence; perhaps, it may turn out upon further examination that this mass may be not placental, but an adherent mesenteric mass of convoluted membrane.

These fœtal fishes were probably sufficiently developed at the time of the parent's death to live independent of the mother.

It appears from the Proceedings of the Academy of Natural Sciences of Philadelphia, for 1854, that Dr. Gibbons, of the Academy of Natural Sciences of San Francisco, "claims priority of description of viviparous fish," in behalf of the gold-shimmering waters of California, and consequently, that State takes precedence over Louisiana. Agassiz, whose sounding (fishing) line has passed the living waters to the most ancient palæozoic rocks, says, in regard to the California viviparous fishes, that "a country which furnishes such novelties in our days, bids fair to enrich science with many other unexpected facts."

The remarks of Dr. Dowler upon a viviparous fish of Louisiana, contained in the above notice, add a few points to the unpublished facts connected with the history of that family. The fish itself is not new; it has already been described and figured in 1821 by Lesueur in the 2d volume of the Journal of the Academy of Natural Sciences in Philadelphia, under the name of Pœcilia multilineata. It belongs to my family of *Cyprinodonts*.* I have had ample opportunity of observing large numbers of this fish during my stay in the South in the spring of 1853, in Mobile and in New Orleans where it is found everywhere in the lagoons in the immediate vicinity of these two cities, and not only of ascertaining that they are viviparous as I have already mentioned in this Journal for July, 1853, (p. 135,) but also of tracing the whole development of the embryo from the first stages of the segmentation of the yolk to the hatching of the young, which were freed from the abdominal pouch of the mother in the month of April. The date of the observations of Dr. Dowler seem to show that they breed twice a year. I should have hastened to publish my investigations had not Duvernoy already published a very full account of the later period of the embryonic growth of another species of this genus, the Pœcilia surinamensis, *Val.*, in the Annales des Sciences Naturelles, 3d series, vol. i, p. 313, plate 17, to which my own observations, except with reference to the earlier changes of the embryo will add comparatively little, when published. That the fish observed by Dr. Dowler is the same as that I had an opportunity of investigating, his description shows very plainly. There is only one fact to which I would call again attention though I have already noticed it before, that the genus Mollienesia of Lesueur is founded upon the male of the same species he has described as Pœcilia multilineata. There can not be the slightest doubt about it, for I have repeatedly seen them copulate, and among a large number of specimens examined, all those that answer to the description of Mollienesia latipinna are males and all those corresponding to the description of Pœcilia multilineata are females. There are several species of this family much smaller than this Pœcilia multilineata. Indeed it contains the smallest representatives of the great type of Vertebrates. My Heterandria formosa, for instance, when full grown, is not quite an inch long and does not weigh more than five grains. An adult male weighed 33½ milligrams.

Cambridge, Aug. 22, 1854. L. AGASSIZ.

13. *Perforating Animals.*—M. Valenciennes observes that there are several Echini that perforate rocks like the Lithodomi. He also states that he has endeavored to obtain evidence of the presence of acid for perforating in different perforating animals, but has never detected the slightest alteration of litmus paper while in contact with them; and he admits that the action is wholly mechanical, proceeding from the incessant friction of the fleshy foot or some other part of the animal.—*L'Institut, Oct.* 11, 1854.

* See Agassiz's Recherches sur les Poissons fossiles, vol. v, part 2d, p. 47.

14. *Mollusca of Irkutsk.*—M. Maack has recently sent to the Academy of St. Petersburg, 27 species of mollusca, both land and fresh-water species, and it is remarkable that all the species without exception, are those of Europe, and pertain even to the most common and most widely distributed species; only four of them had not previously been observed in Siberia.—*L'Institut, Oct.* 11, 1854.

IV. Astronomy.

1. *Elements of Urania* (30), (Compt. Rend. Acad. Sci., tome xxxix, p. 644.)—Mr. Oudemans has computed the following elements of this planet from the Regent's Park observations of July 22, and those of Leyden of August 12 and Sept. 5.

Epoch July 22·0 Greenwich M. T.

Mean anomaly, - - -	298° 13′ 17″ ·4	
Long. perihelion, - - -	26 42 59 ·3	Mn. Eqnx.
" asc. node, - - -	307 57 51 ·15	1854·0.
Inclination, - - - -	1 56 41 ·7	
Angle of excentricity, - -	8 54 39 ·2	
Mean daily motion, - - -	979·715	
Semi axis major, - - - -	2·35833	

2. *Comet*, 1854, IV, (Astron. Journal, 77 and 78.)—Mr. Van Arsdale has been anticipated in the discovery of this comet by Mr. Klinkerfues, who saw it on the 11th of September. The following parabolic elements of its orbit are published by Dr. B. A. Gould, Jr.:

T. 1854, Oct. 27·35980 Greenwich M. T.

Perihelion passage, - - -	94° 12′ 49″·1	Mn. Eqnx.
Long. asc. node, - - - -	324 35 33 ·9	1854·0.
Inclination, - - - -	40 59 28 ·8	
Log. q. - - - -	9·903504.	

3. *New Planets.*—Two new asteroids have been discovered in Paris: one Oct. 27, by Mr. Goldschmidt, which has been named Pomona (32), and the other Oct. 29, by Mr. Chacornac, named Polymnia (33). Their positions at that time were:

(32) R. A. $2^h\ 24^m$ and Dec. $+14°\ 55'$
(33) " $2^h\ 34^m$ " " $+16°\ 58'$

V. Miscellaneous Intelligence.

1. *On the Means of Realizing the Advantages of the Air-Engine;* by William John Macquorn Rankine, Civil Engineer, F.R.S.S., Lond. and Edin., &c.—This paper consists of four sections. In the first are explained the two fundamental laws of the mechanical action of heat, and their application to determine the efficiency of theoretically perfect engines working between given limits of temperature; and it is shown that, as the efficiency increases with the distance between those limits, and as it is easy to employ air with safety at temperatures far exceeding that at which the pressure of steam would cease to be safe and manageable, the maximum theoretical efficiency of air-engines, consistent with safety, is much higher than that of steam-engines. For example, at the temperature of 650° Fahr., at which the air-engine has

been successfully worked, the pressure of steam is 2100 lbs. on the square inch, while that of the air is optional, being regulated by the density at which the air is employed.

In the second section, the various causes of waste of heat and power in steam-engines are classified, and the actual efficiency of steam-engines is compared with their maximum theoretical efficiency, and also with the maximum actual efficiency, which may reasonably be supposed to be attainable in the steam-engine, by means of any probable mechanical improvements.

The following are estimates of the consumption of bituminous coal of a specified quality, per horse-power per hour :—

1. For a theoretically perfect engine working between such limits of temperature as are usual in steam-engines,............ 1.86 lbs.
2. For a double acting steam-engine improved to the utmost probable extent,.................................... 2.50 "
3. For a well constructed and properly worked ordinary double acting engine, on an average,........................ 4.00 "

In the third section, the causes of waste of heat and power in air-engines, are classified in a manner analogous to that applied to steam engines ; and the actual efficiencies of those previous air-engines, as to which satisfactory experimental data have been obtained, namely, Stirling's engine and Ericsson's engine of 1852, are compared with the efficiencies of theoretically perfect engines working between the same limits of temperature, the results being as follows, so far as they relate to the consumption of coal of the specified quality per horse-power per hour :—

	Actual Consumption.	Consumption of a Theoretically Perfect Engine.
Stirling's Engine,............	2.20 lbs.	0.73 lbs.
Ericsson's Engine,...	2.80 "	0.82 "

It is thus proved that an air-engine has actually been made to work successfully, and to realize an economy of fuel considerably superior to that of ordinary steam-engines, and, in fact, surpassing the utmost limit to which it is probable that the economy of double-acting steam-engines can ever be brought. Stirling's engine, as finally improved, was compact in its dimensions, easily worked, not liable to get out of order, and consumed less oil, and required fewer repairs than any steam-engine. Still the advantages shown by that engine over steam-engines were not so great as to induce practical men to overcome their natural repugnance to exchange a long tried method for a new one ; another circumstance caused Stirling's and Ericsson's engines to meet with neglect from scientific men, namely, that both were by some persons represented as instances of *power created out of nothing*—the popular delusion commonly called "*perpetual motion.*" It is shown that Stirling's air-engine, as compared with a theoretically perfect air-engine, wasted two-thirds of its fuel, and Ericsson's somewhat more.

Two obvious and powerful causes of that waste of fuel are traced—1. Deficiency in extent of heating surface. 2. The communication of heat from the furnace to the working air at those periods of the stroke when it is not performing work.

The necessary conclusion is, that the more completely we remove those two causes of waste of fuel, the more nearly shall we approximate to the theoretical extent of the economy of the air-engine—an extent far exceeding that to which the economy of the steam-engine is restricted ; and the more fully, in short, shall we accomplish that which has hitherto been very imperfectly done—to REALIZE THE ADVANTAGES OF THE AIR-ENGINE.

The fourth section describes the improved air-engine of Messrs. James Robert Napier and W. J. Macquorn Rankine. In this engine the heating surface is increased to any required extent, by means of tubes employed in a peculiar manner. The waste of heat by its communication to the air, at improper periods of the stroke, is prevented by a sort of plunger, called the heat-screen, which prevents any access of the air to the heating surface, except when it is in the act of expanding, and so performing work. The engine may be made of the same size with a steam-engine of the same power, or smaller, according to the degree of condensation at which the air is employed. The air receivers of an experimental engine were completed some time since, without practical difficulty, notwithstanding the novelty of their construction ; but the erection of the engine has been retarded by delay in the execution of the cylinder, fly-wheel, shaft, and other parts, which are similar to those of a steam-engine.

Independently of the amount and value of the saving of fuel, which will result from the introduction of the air-engine, it possesses the important and incontestable advantage, that even should an air receiver burst (which is very unlikely), the explosion would be harmless, for its force would not be felt beyond the limits of the engine itself. Red-hot air does not scald.—*Proc. Brit. Assoc., Sept.*, 1854.

2. *On Lightning Conductors*, (Proc. Brit. Assoc., Athen., No. 1405.)—Mr. NASMYTH described a Lightning Conductor for Chimneys, which he conceived affords more perfect insulation, and is therefore safer than those in common use. The present practice is to fix the conductor outside the chimney by metal holdfasts, by which means during severe thunder-storms chimneys are often damaged by the lightning entering at the points of attachment and displacing the bricks. In the method of fixing the conductor recommended by Mr. Nasmyth, the metal rod is suspended in the middle of the chimney by branching supports fixed on the top. A conductor of this kind had proved efficient in storms which had severely injured other chimneys in the neighborhood that were protected in the usual manner. An experience of eighteen years had tested the superiority of the plan.

Prof. FARADAY, on being called on for his opinion, said that he recommended that *lightning conductors should be placed inside instead of outside of all buildings.* He had been consulted on that point when the lightning conductor was fixed to the Duke of York's Pillar, and he advised the placing it inside, but his advice was not taken, and the rod was fixed outside, to the great disfigurement of the column. All attachments of metal to or near the conductor are bad, unless there be a continuous line of conduction to the ground. He mentioned the instance of damage done to a lighthouse in consequence of part of the discharge of lightning having passed from the conductor to the lead fastenings of the stones. The practical question for consideration by the Mechanical Section was, how far they could safely run lead between the stones of such a structure, for if it were done partially, leaving a discontinuous series of such metallic fastenings, there would be great danger of the stones being displaced by the electric discharge. When such fastenings are used, care should be taken that they are connected together and with the earth by a continuous metallic conductor. Some persons conceived that it is desirable to insulate the conductor from the wall of a building by glass, but all such contrivances are absurd, since the distance to which the metal could be removed from the wall by the interposed insulator was altogether insignificant compared with the distance through which the lightning must pass in a discharge from the clouds to the earth. On being asked whether a flat strip of copper was not better than a copper rod, Prof. Faraday said the shape of the conductor is immaterial, provided the substance and quality of the metal are the same.

3. *On the Effect of Pressure on the Temperature of Fusion of different Substances;* by MR. HOPKINS, (Proc. Brit. Assoc., Athen., No. 1406. —The author began by stating that it was most fortunate for the success of his researches that, in the very commencement of them he had applied to Mr. W. Fairbairn, who had with the utmost enthusiasm, entered into his views, and aided him to the utmost extent of the incomparable facilities afforded by his celebrated establishment. Mr. Hopkins then gave a short description of the apparatus which he had used, and the successive steps by which failures in some contrivances had led him to that which was ultimately found to answer. In particular, how, from the enormous pressures to which the substances were subjected, they found it impossible to use glass to see what was going on within the cylinders in which the substance to be experimented upon was inclosed; which difficulty had been got over by causing an iron ball to rest on the top of the substance within the cylinder, while its presence deflected a small magnetic needle outside, but the instant the melting of the substance inside permits the ball to fall, the magnetic needle returning to its position of rest indicated the fact. The use of this needle made it necessary to make the cylinder of brass; and Mr. Hopkins stated that with the first cylinder they used, they were surprised to find when enormous pressures were laid on, that the liquid within wasted; the cause of this they long sought to discover in vain, until at length they found that it was escaping through the very pores of the metal in thousands upon thousands of jets so minute as to be almost imperceptible. This they remedied by greater care in the casting of the cylinder, and hammering it well on the outside. The method of laying on the pressure was by a piston well packed and forced down by a lever. This they adopted as the simplest means of getting a numerical estimate of the actual compressing force. Mr. Hopkins then described the method by which the friction had been determined which opposed the motion of the piston, and so diminished the pressure by so much. This was done by noting the weight required to drive the piston in a certain small distance: this, less by the friction, was equal to the compressing force; then noting the weight which allowed the piston to return exactly to its first position: this, together with the friction is equal to the compressing force; but as these two compressing forces are equal, the friction is equal to half the difference of the two weights used, and is then a matter of very simple calculation. Mr. Hopkins then gave the results of the experiments, of which the following are the most important:—

Substances experimented upon.	Pressure in lbs. to the square inch.			Temperature, Fahr., at which it liquefied.		
Spermaceti, -	0	7,790	11 880	124°	140°	176 5°
Wax, - - -	0	7,790	11,880	148·5	166·5	176 5
Sulphur, - -	0	7,790	11,880	225	275·5	285
Stearine, - -	0	7,790	11,880	158	155	165

Of course when the weight 0 was on the pistòn, the substance was under atmospheric pressure, or about 15 lbs. to the square inch ; and the pressure of 7,790 to the square inch was just that at which the Britannia Bridge had been raised. Mr. Hopkins had also tried the metallic alloys which fuse at low temperatures, but had not detected any elevation of fusing temperature required by increasing the pressure ; but these experiments required to be repeated and confirmed before they could be relied upon.

4. *M. Foucault's Nouvelles Expériences sur le mouvement de la terre au moyen du Gyroscope*,* (Proc. Brit. Assoc., Athen., No. 1406.) —The author spoke in French, but very distinctly, and the apparatus was so simple, beautiful, and exquisitely constructed, that the experiments all succeeded to a miracle, and fully interpreted the author's meaning as he proceeded. The gyroscope is a massive ring of brass connected with a steel axis by a thinner plate of the same metal, all turned beautifully smooth, and most accurately centred and balanced ; in other words, the axis caused to pass accurately through the centre of gravity, and to stand truly perpendicular to the plane of rotation of the entire mass. On this axis was a small but stout pinion, which served when the instrument was placed firmly on a small frame, containing a train of stout clock-work, turned by a handle like a jack, to give it an exceedingly rapid rotatory motion on its axis. But to this clock-work frame it could be attached, or detached from it, instantly. This revolving mass was only about three inches wide, and four of them were mounted in frames a little differently. The first was mounted in a ring, attached to a hollow sheath, which only permitted the axle and the pinion to appear on the outside, so that it could be laid hold of, or grasped firmly in the hand, if the pinion were not touched, while the mass inside was rapidly revolving without disturbing that motion. By this modification of the gyroscope, the author afforded to the audience a sensible proof of the determination with which a revolving mass endeavors to maintain its own axis of permanent stable rotation, for upon setting it into rapid rotatory motion, and handing it round the room, each person that held it found himself forcibly resisted in any attempt to turn it round either in his fingers, to the right hand or left, or up or down, or in his hands if he swung it round. So that the idea was irresistibly suggested to the mind, that there was something living within which had a will of its own, and which always opposed your will to change its position. The second modification presented the mass suspended in a stout ring, which was furnished with projecting axles, like the ring of the gimbal. These axles could be placed in a small frame of wood bushed with brass. This small frame, when placed on a piece of smooth board, could be turned freely round by turning the piece of board on which it rested as long as the gyroscope was not revolving, friction being sufficient to cause the one to turn with the other; but,

* See this Journal, xv, 263.

when the gyroscope was set rapidly revolving, in vain you attempted to turn the frame, by turning the board on which it rested, so determinately did it endeavor to maintain its own plane of rotation, as quite to overpower the friction. In the third modification of the gyroscope it was suspended in gimbals, so exquisitely constructed that both the gyroscope proper and the supporting gimbals were accurately balanced, so as to rest freely when placed in any position in relation to the earth. By this the author showed most strikingly the effect of any attempt to communicate revolving motion round any other axis to a mass already revolving, for, on placing the gimbals in a frame of wood while the gyroscope was not revolving, it remained quite steady; but, when thrown into rapid revolving motion, the slightest attempt to turn the frame round to the right or to the left was instantly followed by the entire gyroscope turning round in the gimbals, so as to bring its axis to coincide with the new axis you endeavored to give it, with a life-like precision, and always so as to make its own direction of revolution be the same as that of the slightest turn you impart to it. Having thus demonstrated the necessary effect of combining one rotatory motion with another, he then proceeded to demonstrate palpably that the earth's revolving motion affected the gyroscope in precisely a similar way. Having, by the screw adjustments, brought the gyroscope, in gimbals, to a very exact balance, it remained fixed in any position when not revolving. But, rapid rotatory motion having been communicated to the gyroscope mass as soon as the gimbal supports are placed on the stand, you see the entire apparatus, slowly at first, but at length more rapidly, turn itself round, nor ever settle until the axis, on which the gyroscope is revolving, arranges itself parallel to the terrestrial axis, in such a sense as to make the direction of the revolving gyroscope to be the same as that of the whole earth. He next showed that the determination with which it did this was sufficient to control the entire weight of the instrument, though that amounted to several pounds, for, taking the ring gyroscope from the side of the ring of which a small steel wire projected, ending in a hook, the wire coincided with the prolongation of the axis of the gyroscope: of course, when not made to revolve, the hook, if placed in a little agate cup at the top of a stand, would permit the instrument, by its weight, to fall instantly, as soon as the support of the hand was taken from it. But, upon imparting to it rapid rotatory motion, it stood up even beyond the horizontal position, so as to bring its axis of rotation nearly to the same inclination to the horizon as the axis of the earth, while the whole acquired a slow rotatory motion round the point of the hook; and so steady was its equilibrium while moving thus, that a string being passed under the hook and both ends brought together in the hand, the whole may be lifted by the cord off the stand and carried revolving steadily about the room. Next, to show the motion of the earth sensibly, he placed the gimbal gyroscope suspended freely by a fine silk fibre in a stand with the lower steel point of its support resting in an agate cup; a long light pointer projecting from the ring carried a pointed card which passed over a graduated card arch of a circle placed concentrically with the gyroscope; upon imparting rapid rotatory motion to the gyroscope, the index was seen as the earth moved to point out the relative motion of the plane of rotation exactly in the same way; the law of the motion being also the same as that of the well-known pendulum experiment. Lastly, he set the ring gyroscope in motion, and by placing a small pointed piece of brass at the end of the axle on the ring, the instrument went immediately through all the evolutions of a boy's top on the floor, humming meanwhile loudly also.

5. *On Meteorolites and Asteroids;* by R. P. GREG, Jr., (Proc. Brit. Assoc., 1854, Athen., No. 1405.)—Mr. Greg brought forward some facts respecting meteorites and asteroids, not hitherto noticed, in favor of the theory that they are identical in nature and origin. After stating some arguments against the theory of the atmospheric origin of aerolites, Mr. Greg proceeded to give an abstract of some results he had lately obtained in analyzing a very complete catalogue of aerolite falls. It would appear that since the year 1500 A.D., there are 175 authenticated instances of falls of aerolites, the month of whose fall is known. The number for each month being as follows:—For January 9, February 15, March 17, April 14, May 15, June 17 falls,—first half of the year, 87 falls; July 18, August 15, September 17, October 14, November 16, December 8 falls,—second half, 88 falls. Giving an average of 14·6 for each month. The most important thing to notice is the small number of aerolites registered for the months of December and January, and the comparatively large number for June and July. The former two showing but 16 instances of falls, the latter two 35, or more than double. Now, granting that these aerolites, or meteorolites, belong to the system of the asteroids, having orbits therefore whose mean distance is superior to the earth's orbit, it is certainly reasonable to conclude that it is when the earth is farthest from the sun, *i. e.* at her aphelion, that the meeting with aerolites is rendered most probable. This is what would appear really to be the case, for the earth is at her greatest distance from that luminary on the side of the summer solstice, *i. e.* in June and July, precisely the months shown to be most abundant in aerolites.

Mr. Greg then referred to a recent number of the *Comptes Rendus*, in which there is a paper by Le Verrier on the asteroids. M. Le Verrier shows by calculation that the sum of the mass of the fragmentary planets called asteroids cannot exceed one-fourth of the earth's mass: and also shows it probable that their mean mass or system is at its perihelion, and consequently nearest the earth, at the time when the earth herself is on the side of the summer solstice. This would appear again confirmatory of the theory that aerolites are the minute outriders of the asteroids. There would appear to be also further evidence, though of another kind. It has been supposed that some of the larger asteroids have irregular and angular surfaces, which is precisely the case with the majority of the meteoric stones which fall to the earth. Again, taking the average specific gravity of aerolites at 3·0 (they vary from 1·7 to 3·9), further indirect evidence is afforded as to their position with regard to distance from the sun, and, taking water as 1·0, the following table shows the relative densities of several of the planetary bodies, following the order of their distances from the sun:—Mercury, 15·7; Venus, 5·9; Earth, 5·9; Mars, 5·2; Aerolites, 3·0; Asteroids, (?), Jupiter, 1·4. Another circumstance relating to aerolites which was alluded to by Mr. Greg was the periodicity of those bodies, and he mentioned more particularly the 19th of May, 29th of November, 13th of December, 15th to 19th of February, and 26th of July, as being aerolitic epochs, aerolite falls having been recorded on the following days:—February 10, 10, 13, 15, 15, 15, 18, 18, 18, 19, 19, 25, 27, 27; May 9, 10, 17, 17, 17, 18, 19, 19, 20, 22, 26, 26, 27, 28; July 3, 3, 4, 7, 8, 12, 14, 17, 18, 22, 24, 24, 26, 26, 26, 30; November 5, 7, 11, 13, 17, 20, 23, 25, 27, 29, 29, 29, 29, 30, 30; December 11, 13, 13, 13, 13, 13, 14, 28. In referring, however, to the epochs most remarkable for the periodical displays of luminous meteors, as November and August 9th to 14th days, Mr. Greg observed that the number of aerolites recorded as falling on those days is remarkably small, indeed under the average of the year, for out of 155 falls (the day as well as month of fall being known), but four have fallen between the 9th and 14th days of August and November. The aerolitic and (luminous) meteoric epochs also would appear to differ, with the exception of the 29th of November.

From this circumstance it seems probable that aerolites, and the majority of luminous meteors (especially periodic and conformable ones), are resolvable into separate classes; and in corroboration of this it may be mentioned, that, while the number of aerolites whose falls have been recorded are about equally divided for the first as for the second half of the year, this is very far from being the case with luminous meteors, by far the larger numbers of which are observed during the second half of the year, viz, from July to December. While, then, we con-consider aerolites as belonging to asteroids, with orbits superior to the Earth's, and partakng of the nature of true though minute planets, the majority of luminous meteors may be considered as having characters more in common with comets. It has been shown by several astronomers, as Olmsted, Peirce, Erman, and others, that the majority of periodic meteors have orbits inferior to the Earth's, and their perihelia near the planet Mercury. Mr. Greg concluded, after making some observations in favor of the self-luminosity of meteors, by suggesting the probability of their having a nature less dense than that of aerolites, but denser than that of comets, and that it is not improbable they have a fluid or viscid nature.

6. *Summary of the Weather for June, at San Francisco, California;* by H. Gibbons, M.D. (From the California Christian Advocate.)

	Mean temp. Sunrise.	Mean temp. Noon.	Mean temp. 10 P.M.	Monthly mean.	Warmest.	Coldest.	Range.	Warmest morning.	Coldest noon.	Proportion clear sky.	Proportion cloudy sky.	Whole days clear.	Whole days cloudy.	Mist.	Winds. NW & N	NE & E	SE & S	SW & W	Windy afternoon.	High winds	Rain.
										days	days	days	days	d's	ds	ds	ds	d's	d'ys	d's	ds
1851	50·90	66·73	51·80	58·81	78	49	29	56	60	20	10	10	0	5	2	1	2	25	24	10	0
1852	51·93	68·87	53·43	60·40	80	49	31	55	64	19	11	9	0	10	1	0	2	27	27	9	1
1853	52·67	71·07	55·57	61·87	87	50	37	60	60	25	5	18	0	7	2	0	2	26	25	8	0
1854	50·10	66·80	51·50	58·45	74	47	27	56	59	24	6	15	0	3	4	0	1	25	25	8	1

In 1851 and 1853 there was no rain, a trace in 1852, and 4 hundredths of an inch in 1854.

From the foregoing table it appears that the last June was the coldest of the series, both the means and extremes being lower than those of the same month in either of the preceding years. In June '51, the mercury was below 50 on four mornings; in '52 on three mornings; in '53 on one morning only; and in '54 on eleven mornings. An unusual tendency to rain existed throughout the month—not the misting or drizzling rain common in the summer; but rain in big drops from the clouds in the higher regions of atmosphere. Light showers fell on the 1st, and on the night of the 11th; and rain fell moderately for several hours on the 17th, $\frac{4}{100}$ths of an inch collecting in the guage. Besides there were threatenings of rain on the 7th and 21st. Though the sea winds were constant and often high, they brought but little mist. The weather of the month was pronounced by general consent to be colder and more unpleasant than is warranted by the common reputation of the summer in this place.

It will be observed that in the four years not a single day occurred in June when the sky was cloudy from sunrise to sunset. This is in character with our summer weather. The mornings are frequently cloudy, without interruption, for one or two weeks, occasionally even for a longer period; but the clouds almost invariably disappear between 8 and 10 o'clock, often returning towards sunset or afterwards, in the form of driving mist. The tendency to cloud at night and in the morning generally increases as the summer advances, so that the number of cloudy mornings is greater in August and September, when the sea breezes have abated in force though not in constancy.

7. *Observations on Atmospheric pressure; from A. and H. Schlagintweit's "Untersuchungen über die physicalische Geographie und die Geologie der Alpen."*—(1.) A diminution of atmospheric pressure causes a small expansion of the thermometer-bulb, and a consequent depression of the zero-point. With delicate thermometers, made with large bulbs and especially with those used for thermo-barometric measures of altitude, the difference can amount, on high summits to 17 or 20 hundredths, (which would correspond to an error of 3 or 4mm. if in computing the atmospheric pressure the change of the zero-point were disregarded.)

(2.) In very great altitudes also, the local forms of the surface are not seldom without influence sufficient to change somewhat the daily range of temperature. Bare walls exposed to the sun act by absorption and subsequent radiation: favorably located snow surfaces can act by reflection so as to increase the maximum. The minimum also can, even in greater heights, be depressed sensibly, if the forms of the peaks favor descending cold currents of air. The increase of temperature which may result even before the appearence of the sun, and after the effect of the descending current has diminished is dependent upon the lateral influx of the free, less cooled masses of air.

(3.) The time of the maximum at high places, nearly agreeing with the culminations of the sun, appears to be somewhat independent of the maximum in the lower parts of the mountains and in the plains. The velocity of the ascending current, not very important on the average, causes that the heat produced in the plains does not ascend to altitudes of 9000 or 10000 feet before the later hours of afternoon.

(4.) On isolated fair days with strong sunshine, the temperature of the air near the ground, even at the height of the snow-region may deviate very sensibly from that of the free columns of air removed from all effect of the heated ground. This heating can sometimes over tolerably extended spaces, amount to a difference of 8 or 10 degrees. This often shows, in the same manner as the corresponding local cooling by descending glacier-winds, an important difficulty in barometric measurement of heights.

(5.) The most important disturbances of the regular diminution of temperature in great surfaces may be produced by the influx of warm winds, which spread themselves generally from the upper regions downward. Sometimes it happens then, that in an air-column of more than 2000 feet height the temperature shows no sensible diminution.

8. *On the Artificial preparation of Sea Water for Marine Vivaria;* by Dr. G. WILSON, (Proc. Brit. Assoc., 1854, Athen., No. 1405.)—The paper was a criticism on a communication made by Mr. Gosse, and contained in "The Annals of Natural History." Guiding himself by Schweitzer's analysis, Gosse employed chlorid of sodium, sulphate of magnesia, chlorid of magnesium and chlorid of potassium. Into a mixed aqueous solution of these salts, Gosse introduced various species of marine plants and animals; and for six weeks they throve and flourished. Dr. Wilson considers, however, that the less abundant, but still essential, constituents of sea-water—such as carbonate of lime, sulphate of lime, phosphate of lime, fluorid of calcium, silica, iodine and bromine—should not be absent, as these latter substances are found in marine plants and animals; and it is therefore plainly evident that the medium in which they live ought to contain the same substances. It is, of course, quite possible that in a single aquarium the death of a certain portion of the animals might furnish calcareous salts, &c., for the growth and preservation of their survivors; and in like manner the death of a given number of plants might liberate iodids, bromids, &c., for the remainder. But this destruction of part of the occupants of the aquarium for the preservation of the other part might be easily avoided, as calcareous phosphates, carbonates and fluorids occur together in shells, corals, and many limestones. The arrangement of fragments of such calcareous bodies at the bottom of the aquarium would supply some of the missing ingredients; whilst pieces of trap rock and a few grains of an iodid and bromid would afford the remainder.

9. *On the Results of Experiments on the Preservation of Fresh Meat;* by Mr. G. HAMILTON, (Ibid.)—This inquiry was undertaken with a view of discovering a method by which beef could be brought in a fresh state from South America. The experiments were made by inclosing pieces of beef in bottles containing one, or a mixture of two or more of the following gases:—chlorine, hydrogen, nitrogen, ammonia, carbonic acid, carbonic oxyd, and binoxyd of nitrogen. Of these, the last two only possessed the power of retarding putrefaction. Beef that had been in contact with carbonic oxyd for the space of three weeks was found to be perfectly fresh, and of a fine red color. Binoxyd of nitrogen is capable of preserving beef from putrefaction for at least five months, during which time the beef retains its natural color and consistence. When meat that had been preserved by the last process was cooked by roasting, it was found to possess a disagreeable flavor. If cooked by boiling, the ebullition must be continued for a much greater length of time than is necessary for fresh meat.

Dr. CALVERT remarked, that he had opportunities of observing the well-known valuable anti-putrid properties of carbolic acid,—and instanced the case of the carcass of a horse that was at present in a fresh state, although four years had elapsed since it had been soaked in liquor containing the acid. He recommended the use of this acid for preserving bodies intended for dissection, as it neither affects the tissues nor discolors the organs.

10. *Magnetic Needle.*—M. Hansteen of Christiana, has made many new observations on the changes which the magnetic needle is undergoing in Europe and Asia. He observes among his results, that the inclination which is diminishing to the west of the line of no declination, is increasing on the contrary, to the east of this line. This law has just been confirmed by M. Simonov, by observations made at Kazan.

11. *Official Report of the United States Expedition to explore the Dead Sea and the River Jordan;* by Lieut. W. F. LYNCH, U. S. N.—Published at the National Observatory, Lieut. M. F. MAURY, U. S. N., Superintendent.—This official Report on the Dead Sea Expedition contains a valuable Report of 150 pages, presenting a "Geological Reconnaisance of part of the Holy Land," by Dr. HENRY JAMES ANDERSON. The general geographical features of the country are described, the characters of the rocks, their composition and fossils, the features of the Dead Sea Valley, the waters and sediment of the Sea, and other particulars of interest. The Fossils, of which there are numerous lithographic plates, are described by Mr. T. A. CONRAD, of Philadelphia. From the various facts this work affords, we cite the following analyses of the sediment and waters of the Dead Sea :—

The sediments were obtained at various depths and distances from the shore. The specimen selected for analysis was procured from a spot where the water had a depth of 116 fathoms, and was not far from the centre of the Sea. For greater precaution against any adventitious matter derived from the vessel in which it had been brought home, (a small well-tinned and closed box,) the portion submitted to analysis was carefully cut out of the interior of the mass which, in the course of the time elapsed (a twelve month) had contracted some degree of hardness. But if there be reason for supposing that the slight metallic addition due to the oxydation of the vessel had already diffused itself through the mud, there could not have been over one per cent. of iron ascribable to this source.

A preliminary experiment showed the following results, due to the moisture yet adherent:

Of 86·2 gr. submitted to a sand-bath heat of 200, after two hours there remained - - - -	76·0
After five " " "	69·5
The next day, after free exposure in the laboratory, -	68·9
After four hours more of sand-bath, - - -	68·7

It then ceased to lose weight.

Of what remained after expelling the retained humidity of this mud, I found soluble in water 20·5 per cent. This was analysed qualitatively and consisted mainly of chlorid of sodium, with minute crystals of which the sediment was plentifully studded. The other chlorids existed nearly as in the Dead Sea water, the chlorid of magnesium being largely in excess.

Of that portion which was not soluble in water there was 57·5 per cent. soluble in hydrochloric acid. An analysis of this gave

Carbonate of lime, - - - - -	74·7 per cent.
Carbonate of magnesia, - - - -	·4
Peroxyd of iron, - - - - - -	12·6
Alumina, - - - - - - -	12·1

The remaining portion (42·5 per cent. of that part which water did not dissolve) was not soluble in hydrochloric acid, and consisted of

Silica, - - - - - - -	85·1 per cent.
Alumina, - - - - - - -	4·9
Peroxyd of iron, - - - - -	2·5
Magnesia, - - - - - - -	3·9
Lime, - - - - - - -	3·3
Alkalies, (traces)	

This portion, as already observed, consisted mainly of a very fine quartz sand with about one-fourth more of minutely triturated silicate powder, derived partly from the basalts of the Valley of the Jordan and partly from the flints of the chalk.

As this specimen was obtained from a part of the Lake not very distant from the focus of the detrital deposits, it may be regarded as exhibiting the maximum of the most transportable matter and the minimum of the least. Yet the carbonate of lime exceeds the silica only in the ratio of 7 to 6. As the ratio of the lime to the silex in the detritus as first detached must far exceed this, it would seem to follow that, notwithstanding the large quantity of carbonate of lime in the Dead Sea sediment (far exceeding that of any marine delta,) a great deal of it has nevertheless disappeared, and must have undergone decomposition before reaching the sea, and probably before arriving at the Jordan.

Another conclusion (and one eminently deserving attention) to which we are brought by this result, if confirmed by further analyses, is that the magnesia so largely incorporated with the lime in the sources of the descending debris, is nearly exhausted on reaching the final resting place of the transported material. Most of the limestones in the Jordan Valley contain at least 2·30 per cent. of magnesia, and the dolomites of the western shore show even 23 per cent. Whereas we find but one-half of one per cent. in the oxylytic portion of the sediment, the only portion probably which has been derived from the calcareo-magnesian rocks. It would seem then that the magnesia in the Dead Sea water is extracted from the rock powder by some other process than vegetable reaction, though this undoubtedly contributes; but I confess myself at a loss to suggest a *rationale* which can satisfactorily explain the extent of this disappearance. If the sediment contained a larger proportion of magnesia there would be no difficulty in looking to the magnesian chlorids in the lavas as competent to the effect, allowing time to do its work; but the carbonates have also contributed their share, and the decomposing process is yet to be detected.

Analysis of the Dead Sea Water.—The quantity submitted to analysis was drawn up by Capt. Lynch himself from a depth of 185 fathoms. The determination of its constituents was very carefully made by Professor Booth, of Philadelphia, assisted by Mr. Alexander Mucklé I subjoin the results as already given in Captain Lynch's Official Report, submitted February 3, 1849.

Specific gravity = 1·22742.

Chlorid of sodium,	78·554
Chlorid of potassium,	6·586
Chlorid of magnesium,	145·897
Chlorid of calcium,	31·075
Bromine salts,	1·374
Sulphate of lime,	·701
	264·186
Water,	735·813
	1000·000

It may be remarked that the great specific gravity of this water does not indicate full saturation with any of the chorids, for the water is still capable of holding much chlorid of sodium, and of course still more chlorid of magnesium in solution. Since, however, crystals of chlorid of sodium remain undissolved at the depth of 116 fathoms,* it follows that the water of the Dead Sea is very unequally charged with its constituents, and that no safe inference can be drawn from an analysis of the surface water, and still less of any specimen in which the depth is not given. I will also add, that in two analyses of Dead Sea water for chlorid of calcium alone, I have found more of this salt than in the analysis above given, in one instance 48 gr. 47 in 1000; but the water was in these cases taken from another part of the Sea.

The fossils described by Mr. CONRAD were either Jurassic or Cretaceous, but mostly the former. Concerning the fossil Ostreidæ, he observes:

It is worthy of remark, that some species of this family and of *Pectenidæ* are widely distributed throughout the globe. Thus *Pecten quinquecostatus* and *Ostrea vesicularis* occur in Syria, Europe and America. *Ostrea falcata* and *Gryphæa vomer* of Morton, originally discovered in the Cretaceous beds of New Jersey, occur in Europe also, where they have since been described under other names, and I have elsewhere stated, that *Exogyra Boussingaultii* is found in Syria, Europe and America.

12. *Illustrations of the Birds of California, Texas, Oregon, British and Russian America;* by JOHN CASSIN. *Philadelphia*, Lippincott, Grambo & Co.—We perceive with great satisfaction that the ornithological illustrations of Mr. Cassin continue to appear as regularly as the pages and plates of such a work can fairly be expected to come forth from the press. We have already No. 7 before us. Like the former, it contains a part of the general synopsis of the birds of North America

* They were found at this depth a little above 'Ain-el-Feshkhah. It is very probable, however, that they may be met with much nearer the surface.

(this time the close of the family of the Owls) and the description of several new or thus far little known species, which are here for the first time handsomely figured. While this book may be particularly acceptable to the lovers of finely illustrated works, and appear as an ornament upon any centre table, it constitutes a highly valuable addition to our scientific literature. To the naturalist who would follow up the general features of the feathered tribes, especially with reference to their geographical distribution and not merely enjoy the diversity of their species, nothing can be more attractive than to behold these careful delineations of birds from the recently annexed parts of the country, which at first sight might appear as simple repetitions of our common species, but are in reality newly discovered representatives of our eastern types in the specific garb they present west and south. L. A.

13. *Orr's Circle of the Sciences—Crystallography and Mineralogy;* Parts I, II, III, by the Rev. Walter Mitchell, M.A., and Professor Tennant. 12 mo, 32 pp. each number. *London.*—In these three numbers, the authors have given the first part of a Treatise on Crystallography. The subject is presented from a mathematical point of view, and with much detail. The system adopted is in its main features that of Prof. Miller; but the symbols of Naumann, and Brooke and Levy, are given, as well as those of this crystallographer. The work promises to be a valuable one to the student of the Science.

14. *Edinburgh New Philosophical Journal.*—A new series of this valuable Journal is announced to commence with the 1st of January, 1855, under the editorial direction of Edward Forbes, F.R.S., Regius Professor of Natural History in the University of Edinburgh, and Thomas Anderson, M.D., F.R.S.E., &c., Regius Professor of Chemistry in the University of Glasgow. With men so eminent in science at the head of this Journal, it will assuredly prove second to none in Great Britain. It will be issued quarterly as before, and retain the general excellent features it presented under Professor Jameson. The editors also propose to give analytical Reviews of Scientific Publications, Reports of the Proceedings of learned Societies, and notices of the contents of foreign Journals. The price of the Journal is reduced to 24s. per year.

[Since the above paragraph was put in type, we have received the following announcement of the death of Professor Forbes.]

" Amongst the younger men of science few have made so brilliant a career, or given promise of so much in the future, as Edward Forbes. Just as his friends were rejoicing in his having attained one of the most distinguished positions his country has to offer for the cultivation of natural history and in the leisure he had won,—looked to as a means of developing the rich store-house of facts and thought he was known to have accumulated,—he has been snatched from us. Never strong, he sunk under a malady from which he had suffered for some years on Saturday last, the 18th of November, in the thirty-ninth year of his age."—*Athen.*, *Nov.* 25, 1854.

15. *Memoria sobre las Antigüedades Neo-granadinas, por* Ezequiel Uricoechoea, 76 pp. small 4to. *Berlin.* Libr. de F. Schneider & Co.—M. Uricoechoea in this work writes like a scholar about a region with which he is familiar, and gives information both ethnological and histor-

ical as well as archæological, respecting the people and country of New Granada. The memoir is illustrated by four lithographic plates, the first representing images in gold of New Granada; the second, Crania; the third and fourth images in stone, and pottery.

16. *Denkschriften der Kaiserlichen Akademie der Wissenschaften, zu Wien.* Vol. vii, of the Mathematico-Natural-History Class, with 56 plates.—This volume of memoirs of the Vienna Academy of Sciences is one among the many scientific publications issued annually at Vienna. Among the papers, there is an elaborate one of 156 pp. by Dr. A. E. Reuss, on the Cretaceous rocks of the eastern Alps, which is illustrated by 31 quarto plates; the larger part of the plates are of fossil corals, and are among the most beautiful as specimens of art and fidelity that we have seen. There is also a paper by E. Suess on the Brachiopods of the beds at Kössen (lower liassic) in the Austrian Alps, with four plates; and another by Fr. Unger, on the Fossil Flora of Gleichenberg.

The Sitzungsberichte or Bulletin of this Academy, a large and elegant 8vo publication, contains in its number for June, 1854, a paper on the Neuration of leaves of the Papilionaceæ, illustrated by numerous (22) plates of leaves taken by the automatic method mentioned in our last number, the leaves themselves making the engraving. The figures stand out on the paper, like actual specimens, and have all the perfection of nature.

17. *Economie Rurale, considérée dans ses rapports avec la Chimie, la Physique et la Météorologie*, par J. B. Boussingault. 2nd edit. 2 vols. 8vo, of 800 to 900 pages. *Paris*, chez Béchat, jeune.—M. Boussingault stands preëminent among the scientific agriculturalists of Europe. To talent of observation, he unites a synthetic power which has conducted him to admirable results. He not only enters into details of Rural Economy as presented in his beautiful place at Bechelbronn (department of the Bas-Rhin); but having seen and travelled much, he finds in his memory, many valuable illustrations of his subject. M. Boussingault has explored the principal volcanoes of America, and has scaled the highest peaks of the Andes; he has ascended Chimborazo, and passed 10 years in Peru and Chili. He recalls much of his travels in his Rural Economy, while still keeping to his subject, thus giving his work a cosmopolitan character. J. Nicklès.

18. *Traité des Arts Ceramiques ou des Poteries considérées dans leur histoire leur pratique et leur theorie par* Alex. Brongniart. 2nd edit. revue et augmentée par M. A. Salvetat. 2 vols. in 8vo, with an Atlas. *Paris*, chez Béchat.—After the French Revolution, the illustrious geologist and mineralogist, Alex. Brongniart was appointed to superintend the reorganization of the Manufacture at Sèvres. He had the direction of this establishment for nearly half a century, and raised it to a degree of splendor which entitles it to the first rank among the manufactures of the world. We owe to the skillful attention of Brongniart, the chefs d'œuvre which call forth so general admiration. By a judicious selection of artists and workmen he brought together a large amount of talent, as was seen at the London Exhibition and will be further exhibited in the Crystal Palace of 1855 at Paris. His position and influence have enabled him to form a Ceramic Museum,

in which all the nations of the globe are represented. A chapter on the potteries of different countries forms an interesting part of his Treatise on the Ceramic Arts. With full liberality all the different processes employed at Sèvres are explained in the work, and M. Salvetat, the pupil of M. Brongniart, has added a history of the art since the death of M. Brongniart in 1847. J. N.

19. *Cours special sur l'Induction, le Diamagnétisme, le Magnétisme de Rotation et sur les relations entre la Force Magnétique et les Actions Moléculaires*, par M. Matteucci. 1 vol. in 8vo, of 280 pages. Paris, Mallet-Bachelier.—This work gives a review of the principal facts in these different branches as brought out both by Matteucci himself and by Arago, Faraday, De la Rive, Becquerel, Ampère, de Haldat, Poggendorff, Weber, etc. J. N.

20. *Nouveau Système de Navigation fondé sur le principe de l'emergence des corps ronds roulant sur l'eau; Hydro-locomotives à grande vitesse portées sur des cylindres roulants; vol á la surface de l'eau*, par Planavergne. A brochure in 8vo. of 100 pages with plates. The work describes and illustrates a new mode of navigation by which the vessel moves over the water instead of in it. J. N.

Transactions of the American Medical Association, vol. vii. 668 pp. 8vo.—This volume contains a paper by F. Peyre Porcher, M.D., of Charleston, S. C., on the Medicinal and Toxicological Properties of the Cryptogamic plants of the United States.

W. J. Macquorn Rankine: On the Geometrical Representation of the Expansive Action of Heat and the theory of Thermodynamic Engines; Trans. Roy. Soc. 1854. p. 115. 60 pp. 4to.

Quetelet: Observations des Phénomènes Périodiques—Mém. Acad. Roy. de Belgique, Tome xxviii. 104 pp. 4to.

J. C. Houzeau: Méthode pour détérminer simultanement la Latitude, la Longitude, l'Heure et l'Azimut, par des passages observés dans deux verticaux; 26 pp. 4to. Mem. Bruss. Acad. *Brussels*, 1853.

F. A. Quenstedt: Handbuch der Mineralogie. 1 Lief. 8vo, 384 pp. Tubingen.

Schlagintweit: Neue Untersuchungen über die Physicalische Geographie und die Geologie der Alpen. 4to, 630 pp. with an Atlas of 22 plates and 8 tables in folio. *Leipzig*. $24.00.

Hinrichs: Das Leben in der Natur Bildungs- und Entwicklungsstufen desselben in Pflanze Thiere und Mensch. 8vo, 271 pp. *Halle*.

Cassaday of Louisville, Ky.: Description of New Crinoids. (In German, from the Zeitsch. d. deutschen geologischen Gesellschaft, Jahrg. 1854.) This memoir describes two new Crinoids from limestone at the foot of Spergen Hill, 25 miles from New Albany, Indiana. They are referred to the new genus Batocrinus, and named *B. icosadactylus* and *B. irregularis*. The head is elongated and the pieces rise into cones over the whole surface.

J. Müller: Ueber den Bau der Echinodermen, 100 pp. 4to, with 9 copper plates of great beauty. *Berlin*, 1854.

C. Vogt: Lehrbuch der Geologie und Petrefactenkunde. 2nd edit. 2 vols, 8vo, 672 and 641 pp., with 16 copper plates and 1136 wood-cuts. *Braunschweig*, 1854.

Proceedings of the Acad. Nat. Sci. of Philadelphia. Vol. vii, No. 5.—p. 167. Descriptions of some new Fossils from the Cretaceous Rocks of the Southern States; M. Tuomey.—p. 172. Description of a fossil apparently indicating an extinct species of the Camel Tribe; J. Leidy.—p. 175. Catalogue and descriptions of Crustacea collected in California by Dr. John L. LeConte; James D. Dana (contains new genera of Isopoda, *Alloniscus* and *Ægacylla*).—p. 177. Additions to North American Ornithology; A. L. Heermann.—p. 180. Descriptions of four new species of Kinosternum; J. LeConte.—p. 190. Observations on the Vespertilio leporinus of Linnæus; J. LeConte.—p. 191. On Urnatella gracilis and a new species of Plumatella; J. Leidy.—p. 193. Descriptions of new Reptiles from Guinea; E. Hallowell.

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CONTENTS.

(*For remainder of Contents, see third page of Cover.*)

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THE

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JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

Art. XV.—*Memoir on Meteorites—A Description of five new Meteoric Irons, with some theoretical considerations on the origin of Meteorites based on their Physical and Chemical characters;* by J. Lawrence Smith, M.D., Professor of Chemistry in the Medical Department of the University of Louisville.

(Read before the American Association for the Advancement of Science, April, 1854.)

1. *Meteoric Iron from Tazewell County, East Tennessee.**

This meteorite was placed in my possession through the kindness of Prof. J. B. Mitchell of Knoxville, in the month of August, 1853. It was found by a son of Mr. Rogers living in that neighborhood, while engaged in ploughing a hill-side; his attention was drawn to it by its sonorous character. As it very often happens among the less informed, it was supposed to be silver or to contain a large portion of that metal. With some difficulty the mass was procured by Prof. Mitchell, and passed over to me. Nothing could be ascertained as to the time of its fall; it is stated among the people living near where the meteorite was found, that a light has been often seen to emanate from and rest upon the hill, a belief that may have had its foundation in the observed fall of this body.

The weight of this meteorite was fifty-five pounds. It is of a flattened shape, with numerous conchoidal indentations, and three annular openings passing through the thickness of the mass near

* Notice of the discovery of this iron was given by me in 1853.—J. L. S.

the outer edge. Two or three places on the surface are flattened, as if other portions were attached at one time, but had been rusted off by a process of oxydation that has made several fissures in the mass so as to allow portions to be detached by the hammer, although when the metal is sound the smallest fragment could not be thus detached, it being both hard and tough. Its dimensions are such that it will just lie in a box 13 inches long, 11 inches broad and 5½ inches deep. The accompanying figure gives a correct idea of the appearance of this meteorite.

1.

The exterior is covered with oxyd of iron, in some places so thin as hardly to conceal the iron, in other places a quarter of an inch deep. Its hardness is so great that it is almost impossible to detach portions by means of a saw. Its color is white, owing to the large amount of nickel present; and a polished surface when acted on by hot nitric acid displays in a most beautifully regular manner the Widmannstättian figures. The specific gravity taken on three fragments selected for their compactness and purity, is from 7·88 to 7·91.

The following minerals have been found to constitute this meteorite: 1st. *Nickeliferous iron*, forming nearly the entire mass. 2nd. *Protosulphuret of iron*, found in no inconsiderable quantity on several parts of the exterior of the mass. 3d. *Schreibersite*, found more or less mixed with the pyrites and in the crevices of the iron, in pieces from the thickness of the blade of a penknife to that of the minutest particles. 4th. *Olivine;* two or three very small pieces of this mineral have been found in the interior of the iron. 5th. *Protochlorid of iron;* this mineral has been found in this meteorite *in the solid state*, which I believe is the first observation of this fact; it was found in a crevice that had been opened by a sledge hammer, and in the same crevice Schreibersite was found. Chlorid of iron is also found deliquescing on the surface; some portions of the surface are entirely free from it, while others again are covered with an abundance of rust arising from its decomposition.

Besides the above minerals two others were found, one a siliceous mineral, the other in minute rounded black particles; both, however were in too small quantity for any thing like a correct idea to be formed of their composition.

The different minerals that admitted of it, were examined chemically, and the following are the results:

1. *Nickeliferous Iron.*—The specific gravity of this iron is as already stated, from 7·88 to 7·91. It is not readily acted on by any of the acids in the cold; nitric acid, either concentrated or dilute, has no action on it until heated to nearly 200° Fahr., when the action commences, and continues with great vigor even after the withdrawal of heat. With reference to the action of sulphate of copper, it is *passive*, although when immersed in a solution of sulphate of copper and allowed to remain for several hours the latter metal deposits itself in spots on the surface of the iron.

Thorough digestion in hot nitric acid dissolves the iron completely. When boiled with hydrochloric acid the iron dissolves with the liberation of hydrogen, leaving undissolved the Schreibersite; but by long continued action this latter is also dissolved with the evolution of phosphuretted hydrogen.

The following ingredients were detected on analysis of two specimens:

	1.	2.
Iron,	82·39	83·02
Nickel,	15·02	14·62
Cobalt,	·43	·50
Copper,	·09	·06
Phosphorus,	·16	·19
Chlorine,		·02
Sulphur,		·08
Silica,	·46	·84
Magnesia,		·24
	98·55	99·57

Tin and arsenic were looked for, but neither of those substances detected. The magnesia and silica are doubtless combined, probably in the form of olivine, and disseminated in minute particles through the iron. The phosphorus is in combination with a given portion of iron and nickel, forming Schreibersite; the 16 per cent. of phosphorus corresponds to 1·15 of Schreibersite: so the metal mass may be looked on as composed of

Nickeliferous iron 98·97, Schreibersite 1·03=100·00.

The composition of the nickeliferous iron corresponds to five atoms of iron and 1 of nickel.

Iron,	5 atoms,	82·59
Nickel,	1 "	17·41=100·00

2. *Protosulphuret of Iron.*—This variety of sulphuret of iron found with meteorites is usually designated as magnetic pyrites, leaving it to be inferred that its composition is the same as the terrestrial variety. Without alluding to the doubt among some mineralogists as to the true composition of the terrestrial magnetic pyrites, I have only to say that most careful examination of the sulphuret detached from the meteorite in question proves it to be a protosulphuret; a conclusion to which Rammelsberg had already come, with reference to the pyrites of the Seelasgen iron, which latter pyrites I have also examined, confirming the results of Rammelsberg.

This pyrites encrusts some portion of the iron, and in places is mixed with a little Schreibersite. It presents no distinct crystalline structure, has a grey metallic lustre, and a specific gravity of 4·75. The Seelasgen pyrites gave me for specific gravity 4·681.

The specimen of pyrites in question gave, on analysis:

Iron 62·38, sulphur 35·67, nickel 0·32, copper *trace*, silica 0·56, lime 0·08=98·91.

The formula Fe S requires sulphur 36·36, iron 63·64.

The magnetic property of this mineral is far inferior to that possessed by Schreibersite.

3. *Schreibersite.*—It is found disseminated in small particles through the mass of the iron, and is made evident by the action of hydrochloric acid; it is also found in flakes of little size, inserted as it were into the iron, and owing to the fact that in many parts where it occurs chlorid of iron also exists, this last has caused the iron to rust in crevices, and on opening these, Schreibersite was detached mechanically. This mineral as it exists in the meteorite in question, so closely resembles magnetic pyrites that it can be readily mistaken for this latter substance, and I feel confident in asserting that a great deal of the so-called magnetic pyrites associated with various masses of meteoric iron, will upon examination, be found not to contain a trace of sulphur, and will on the contrary prove to be Schreibersite that can be easily recognised by the characters to be fully detailed a little farther on.

Its color is yellow or yellowish white, sometimes with a greenish tinge; lustre metallic; hardness 6; specific gravity 7·017. No regular crystalline form was detected; its fracture in one direction is conchoidal. It is attracted very readily by the magnet, even more so than magnetic oxyd of iron; it acquires polarity and retains it. I have a piece $\frac{3}{10}$ of an inch long, $\frac{2}{10}$ of an inch broad, and $\frac{1}{20}$ of an inch thick, which has retained its polarity over six months; unfortunately the polarity was not tested immediately when it was detached from the iron, and not until it had come in contact with a magnet, so that it cannot be pronounced as originally polar.

Before the blowpipe it melts readily, little blisters forming on the surface from the escape of *chlorine*, and blackens. The magnet is a most ready means of distinguishing the Schreibersite from the pyrites commonly found in meteoric irons, for although the pyrites is attracted by the magnet, it is necessary that the latter should be brought quite near to it for the effect to be produced, whereas if the particles exposed to the magnet be Schreibersite, they will be attracted with almost the readiness of iron filings.

Hydrochloric acid acts exceedingly slowly on this mineral when pulverized, with the formation of phosphuretted hydrogen. Nitric acid acts more vigorously and readily dissolves it when finely pulverized. The composition of this substance has in all cases but one, been made out from the residue of meteoric iron, after having been acted on by hydrochloric acid, which accounts for the great variation in the statements of the proportion of its constituents.

Mr. Fisher examined pieces of Schreibersite detached from the Braunau iron, with the following results: Iron 55·430, nickel 25·015, phosphorus 11·722, chrome 2·850, carbon 1·156, silex 0·985=98·158.

The results of my analyses do not differ very materially from this; they are as follows:

	1.	2.	3.
Iron,	57·22	56·04	56·53
Nickel,	25·82	26·43	28·02
Cobalt,	0·32	0·41	0·28
Copper,	*trace*	not estimated.	
Phosphorus,	13·92		14·86
Silica,	1·62		
Alumina,	1·63		
Zinc,	*trace*	not estimated.	
Chlorine,	0·13		
	100·66		99·69

Nos. 1 and 2 were separated mechanically from the iron. No. 3 chemically. The silica, alumina and lime were almost entirely absent from No. 3, and in the other specimen they are due to a siliceous mineral that I have found attached in small particles to the Schreibersite. There is no essential difference in my results, yet in neither instance do I suppose the mineral was obtained perfectly pure; although enough so, it is believed, to furnish the correct chemical formula; and, as from what has been previously said, Schreibersite will be found to exist in larger quantities than it was suspected, it will not be long before the question of the uniformity of its composition will be settled, a point of interest bearing upon the theoretical consideration of meteoric stones.

The formula of Schreibersite, I consider to be Ni_2Fe_4P.

		Per cent.
Phosphorus,	1 atom	15·47
Nickel,	2 "	29·17
Iron,	4 "	55·36

This mineral although not usually much dwelt upon when speaking of meteorites, is decidedly the most interesting one associated with this class of bodies, even more so than the nickeliferous iron. It has no representative in genus or species among terrestrial minerals, and is one possessed of highly interesting properties. Although among terrestrial minerals phosphates are found, not a single phosphuret is known to exist; so true is this (that with our present knowledge) if any one thing could convince me more strongly than another of the non-terrestrial origin of any natural body, it would be the presence of this or some similar phosphuret. It is commonly alluded to as a residue from the action of hydrochloric acid upon meteoric iron, when in fact it exists in plates and fragments of some size in almost all meteoric iron; and there is reason to believe that it is never absent from any of them in some form or other: what is meant by "some size" is, that it is in pieces large enough to be seen by the naked eye, and to be detached mechanically.

In an examination of the meteoric specimens in the Yale College Cabinet, more than half of them have been discovered to contain Schreibersite visible to the eye, that had been considered pyrites. Among them, the large Texas meteorite was examined, and although none was visible on the surface, a small fragment of the same mass given me by Prof. Silliman, contains a piece of Schreibersite of over a grain weight.

The reason why it has not attracted more attention, arises from its resemblance to pyrites; I will therefore state a ready manner of telling whether it be such or not.

Detach a small fragment, and hold a magnet capable of sustaining five or six ounces or more, within half an inch or an inch of the fragment, if it be Schreibersite it will be attracted with great readiness; the magnetic pyrites requiring a very close approximation of the magnet before attracted. This, with some little experience, becomes a ready method of separating the two. It is not, however, to be expected that this method alone, is to satisfy us, when other means can be appealed to for distinguishing this mineral; the following is one which is readily accomplished with the smallest fragment (half a milligramme). Melt in a small loop of platinum wire, a little carbonate of soda, add the smallest fragment of nitrate of soda and the piece of mineral, hold the mixture in the flame of a lamp for two or three minutes; place the bead of soda in a watch glass, add a little water and filter; to the filtrate add a drop or two of acid to neutralize the excess of carbonate of soda; evaporate nearly to dryness; add a drop of ammonia, and then a drop of ammoniacal sulphate of magnesia, when the double phosphate of magnesia and ammonia will show itself, and the crystalline form will be recognised under the microscope. If the piece examined be several milligrammes in weight, the operation can be carried on in a small platinum capsule. This reaction can also be had by acting on the mineral, however small the piece, by aqua-regia, evaporate until only a little of the liquid is left, add a little tartaric acid, then a drop or two of ammonia to supersaturate the acid, and lastly a little ammoniacal sulphate of magnesia, when the crystals of the double phosphate of magnesia and ammonia will appear.

4. *Protochlorid of Iron.*—In breaking open one of the fissures of this meteoric iron, a small amount of a green substance was obtained, that was easily soluble in water, and although not analyzed quantitatively, it left no doubt upon my mind as to its being protochlorid of iron; and the manner of its occurrence gave strong evidence of its being an original constituent of the mass, and not formed since the fall of the mass. Chlorid of iron was apparent on various parts of the iron by its deliquescence on the surface.

2. *Meteoric Iron from Campbell County, Tenn.*

This meteorite was discovered in July, 1853, in Campbell County, Tennessee, in Stinking Creek, which flows down one of the narrow valleys of the Cumberland mountains. It was found by a Mr. Arnold in the channel of this stream, and having been obtained by Prof. Mitchell of Knoxville, he kindly presented it to me. It is a small oval mass 2¼ inches long, 1¾ broad, and ¾ thick, with an irregular surface and several cavities perforating the mass. It was covered with a thin coat of oxyd; and on one half of it chlorid of iron was deliquescing from the surface, while on another portion there was a thin siliceous coating.

The iron composing the mass was quite tough, highly crystalline, and exhibited small cavities on being broken, resembling very much in this respect, as well as in many other points, the Hommony Creek iron; a polished surface when etched, exhibited distinct irregular Widmannstättian figures.

The weight is 4⅓ ounces. Specific gravity, 7·05. The lowness of the specific gravity is accounted for by its porous nature. Composition—

Iron,	97·54
Nickel,	0·25
Cobalt,	0·6
Copper, too small to be estimated.	
Carbon,	1·50
Phosphorus,	0·12
Silica,	1·05
	100·52

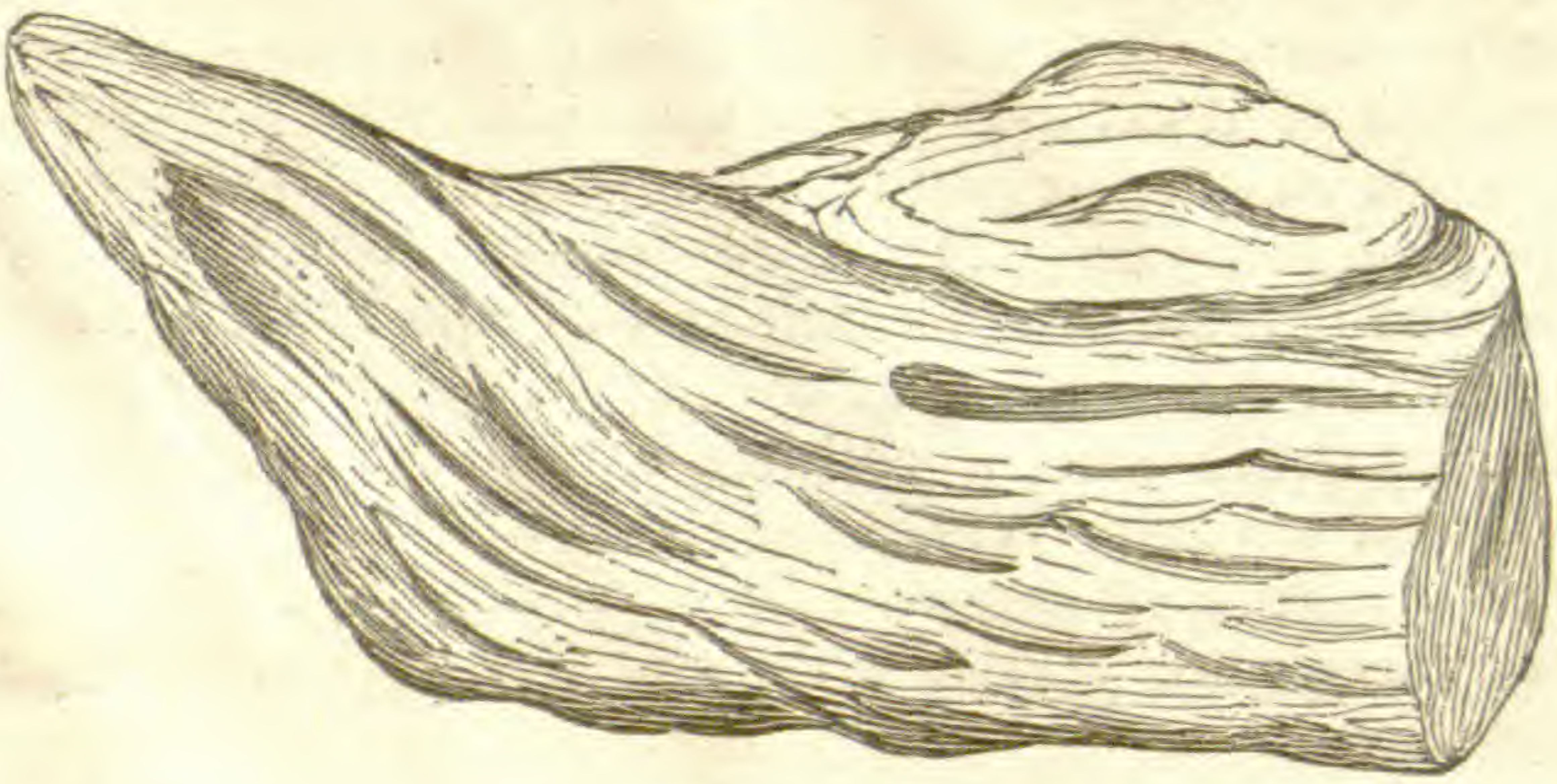
Chlorine exists in some parts in minute proportion. The amount of nickel, it will be seen is quite small, but its composition is nevertheless perfectly characteristic of its origin.

3. *Meteoric Iron from Coahuila, Mexico.*

This meteorite was brought to this country by Lieut. Gouch, of the U. S. Army, he having obtained it at Saltillo. It was said to have come from the Sancha estate, some fifty or sixty miles from Santa Rosa in the north of Coahuila; various accounts were given of the precise locality, but none seemed very satisfactory. When first seen by Lieut. Gouch, it was used as an anvil, and had been originally intended for the Society of Geography and Statistics in the city of Mexico. It is stated that where this mass was found, there are many others of enormous size; these stones, however, it is well known, are to be received with many allowances. Mr. Weidner, of the mines of Freiberg, states that near the southwestern edge of the Balson de Mapimi, on the route to the mines of Parral, there is a meteorite near the road of not less than a ton weight. Lieut. Gouch also states that the intelligent but almost unknown Dr. Berlandier, writes in his journal of the commission of limits, that at the Hacienda of Venagas there was (1827) a piece of iron that would make a cylinder one yard in length with a diameter of ten inches. It was said to have been brought from the mountains near the Hacienda. It presented no crystalline structure, and was quite ductile.

The meteoric mass in question, which is at the Smithsonian Institution, is of the form represented in the figure, and one well

2.



adapted for an anvil. Its weight is 252 lbs., and from several flattened places, I am led to suppose that pieces have become detached. The surface, although irregular in some places, is rather smooth, with only here and there thin coatings of rust, and, as might be expected, but very feeble evidence of chlorine, and that only on one or two spots on the surface. Specific gravity 7·81. It is highly crystalline, quite malleable, and not difficult to cut with the saw. Its surface etched with nitric acid, presents the Widmannstättian figures, with a finely specked surface between the lines, resembling the representation we have of the etched surface of Hauptmannsdorf iron. Schreibersite is visible in the iron, but so inserted in the mass, that it cannot be readily detected by mechanical means. Hydrochloric acid leaves a residue of beautifully brilliant patches of this mineral.

Subjected to analysis, it was found to contain

Iron,	95·82	Which corresponds to	
Cobalt,	·35		
Nickel,	3·18	Nickeliferous Iron,	98·45
Copper, minute quantity not estimated.		Schreibersite,	1·55
Phosphorus,	0·24		
	99·59		100·00

The iron is remarkably free from other constituents. It is especially interesting as the largest mass of meteoric iron in this country next to the Texas meteorite at Yale College.

4. *Meteoric Iron from Tucson, Mexico.*

We have had several accounts of meteoric masses which exist at Tucson; Dr. J. L. LeConte having made them known some few years ago. Since that time Mr. Bartlett, of the Boundary Commission, has seen them and made a drawing of one which he has kindly allowed me the use of, as well as the manuscript* notice of them, which is however, quite brief. This mass is used for an anvil, resembles native iron, and weighs about six hundred pounds. Its greatest length is five feet. Its exterior is quite smooth, while the lower part which projects from the larger leg is very jagged and rough. It was found about twenty miles distant towards Tubac, and about eight miles from the road where we are told are many larger masses. The following figure (3) represents the appearance of that meteorite.

Since my communication last April, I have obtained fragments of the meteorite from Lieut. Jno. G. Parke, of the U. S. Topographical Engineers, who cut them from the mass at Tucson, and to whose kindness I feel much indebted.

Some of the fragments were entirely covered with rust, and in some parts, little blisters existed, arising from chlorid of iron. Portions of the broken surface retain their metallic lustre untarnished. The Widmannstättian figures are very imperfectly developed, owing to the porous nature of the iron, the pores of which are filled with a stony mineral. The specific gravity taken on three specimens were 6·52—6·91—7·13. The last was the most compact and free from stony particles that could be found, and upon that the chemical examination was made.

* Since this was communicated to the American Association for the Advancement of Science, Mr. Bartlett's valuable and instructive work, entitled "Personal Narrative of Explorations in Texas, New Mexico, California, Sonora, and Chihuahua," has been published in two handsome octavo volumes, by the Messrs. Appleton's, New York: and we are indebted to the publishers for the use of Mr. Bartlett's fine cuts on the following pages.—J. L. S.

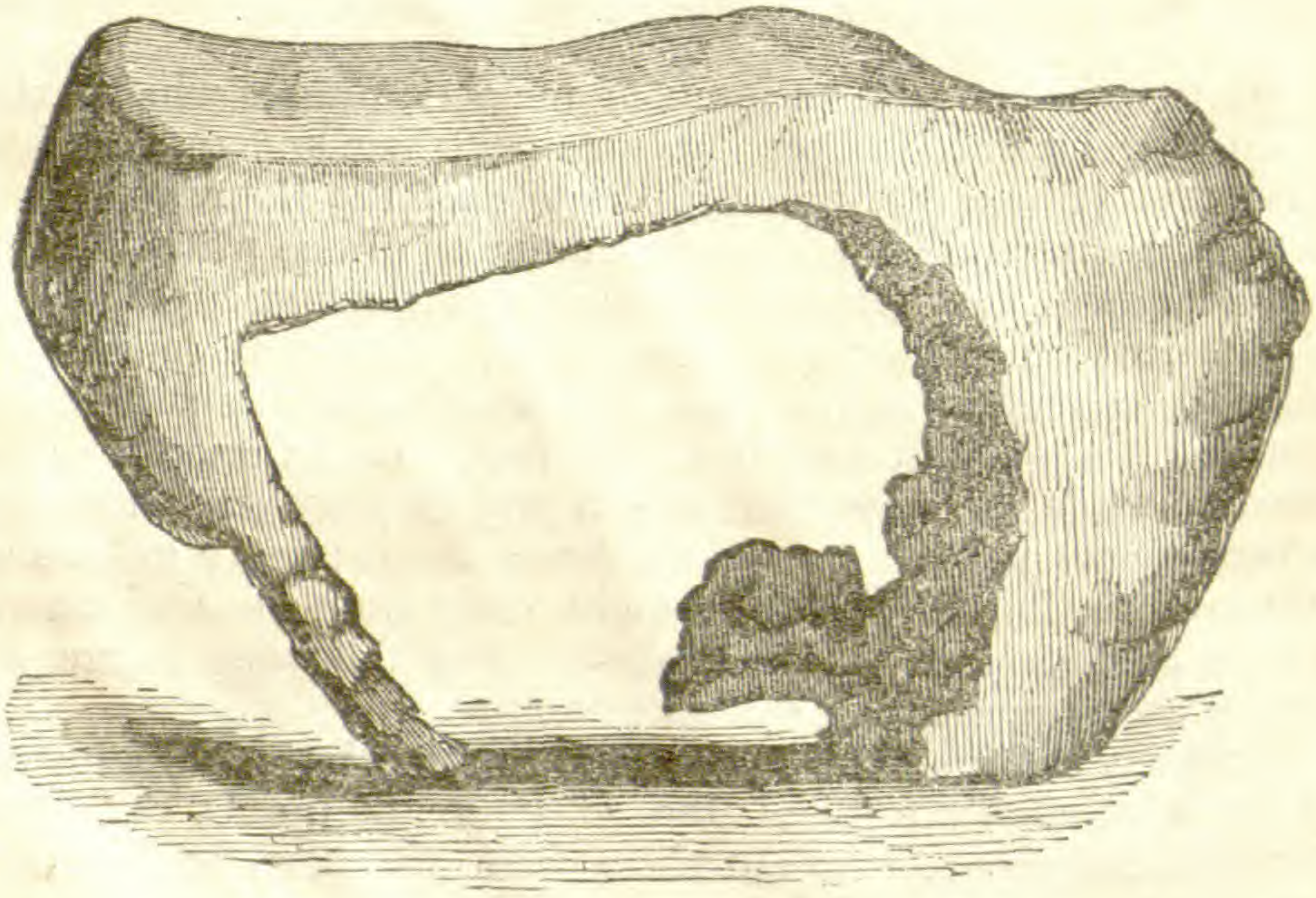
On examination it is seen to consist of two distinct parts, metallic and stony; the latter was only in minute particles, yet it was impossible, among the specimens at my disposal, to find a piece that was without it. On analysis, the following ingredients were found:

Iron,	85·54
Nickel,	8·55
Cobalt,	·61
Copper,	·03
Phosphorus,	·12
Chromic oxyd,	·21
Magnesia,	2·04
Silica,	3·02
Alumina.	*trace*
	100·12

Which represent the following minerals:

Nickeliferous iron,	93·81
Chrome iron,	·41
Schreibersite,	·84
Olivine,	5·06
	100·12

3.



Some few particles of olivine were separated mechanically, and readily recognised as such under the magnifying glass in connection with the action of acids, which readily decompose it, furnishing silica and magnesia. Some of the olivine is in a pulverulent condition, resembling that of the Atacama iron. The nickeliferous iron of this Tucson meteorite also resembles that of the Atacama iron; calculated from the above results, it consists of

Iron 90·91, nickel 8·46, cobalt 63, copper, *trace*=100·00.

This meteorite* is one of much interest, and it is to be hoped that some of our enterprising U. S. Topographical Engineers

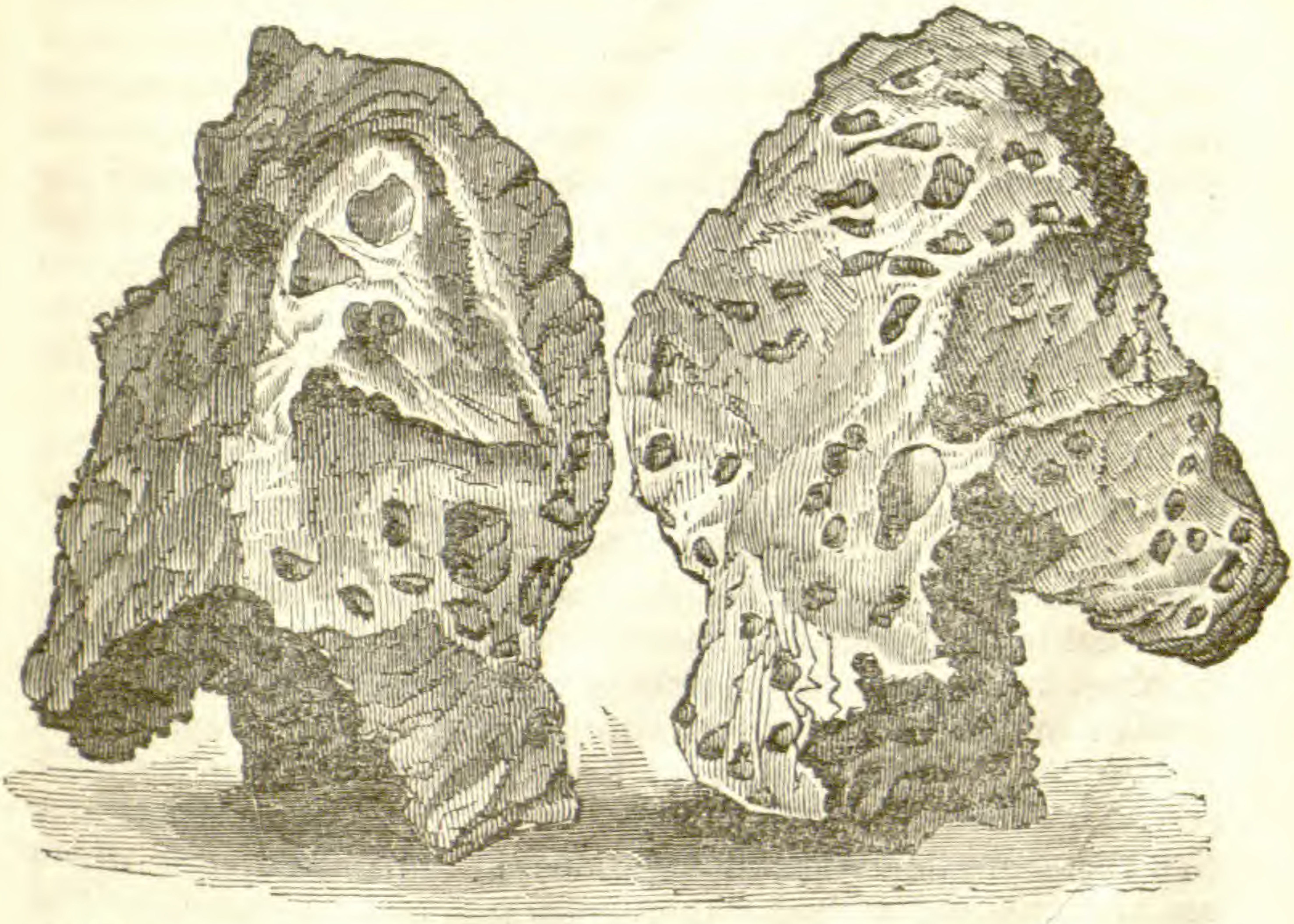
* Since my notice of this meteorite, Prof. C. U. Shepard has published (Am. Journal of Science, Nov. 1854) an account of it, not aware of my communication to the Am. Assoc. He seems inclined to think that the stony material might be chladnite, although he could form no definite conclusion on this head. From what has

will yet be able to persuade the owners to part with it and bring it to this country.

5. *Meteoric Iron of Chihuahua, Mexico.*

For the description of this meteorite, I am indebted to the manuscript of Mr. Bartlett, and had hoped to have obtained a fragment of it for examination from Dr. Webb, who detached pieces from the mass; but when applied to, they were no longer

4.



in his possession. It exists at the *Hacienda de Conception*, about ten miles from Zapata. "The form is irregular. Its greatest height is forty-six inches; greatest breadth thirty-seven inches; circumference in thickest part eight feet three inches. Its weight as given by Senor Urquida, is about three thousand eight hundred and fifty-three pounds. It is irregular in form, as seen by the figure; and one side is filled with deep cavities, generally round and of various dimensions. At its lower part, as it now stands, is a projecting leg, quite similar to the one on the meteorite at Tucson. The back or broadest part is less jagged than the other portions, and contains fewer cavities, yet, like the rest, is very irregular."

been said in the text, it will be seen to be olivine, the chladnite of the Bishopville stone not being attacked by acid, or only to a very feeble extent, by boiling sulphuric acid. And I would here remark that from some investigations just made, chladnite is likely to prove a pyroxene.—J. L. S.

(*To be continued.*)

Art. XVI.—*On the Periodical Rise and Fall of the Lakes;* by Major Lachlan, Montreal.

(Continued from p. 71.)

Such continued to be the state of the question, till the institution, by the American States, of those great patriotic works, the Geological Surveys of New York, Ohio, and Michigan, when the subject being taken up by the talented individuals employed in that duty, as far as their other immediate avocations would permit, with that spirit which ever distinguishes the lovers of science, I was enabled to glean many interesting additional particulars from their official reports, though, unfortunately, none sufficiently conclusive to solve the great philosophical problem so long under discussion. Among these I, of course rank first the eminent American geologist, Professor Hall, from whose elaborate work, put forth under the enlightened auspices of the State of New York, I extract the following valuable remarks on the elevation and depression of the great Lakes:*

"The fluctuating level of the waters of these Lakes has long excited attention; and many speculations have been hazarded to account for the phenomenon. The somewhat general belief that the periodical rise and fall in their waters occupy seven years appears not to be founded on authentic observation. Sand-bars and beaches, or the inlets of certain bays, are regarded as the landmarks; and these being liable to fluctuation from accumulation and removal, it follows that no hypothesis, founded on such observations, can be of any value. . . It is nevertheless true that there are important fluctuations in the Lake levels, which are unconnected with the temporary influence of winds. The only rational explanation of these changes yet afforded is that depending on the waste and supply of water. From the immense surface exposed to the sun's rays, it is plain that the amount of water evaporated is immense; and if by any means the process becomes retarded, the water is elevated. Again, the greater quantity of snow fallen during certain seasons has been considered a sufficient reason for explaining the increased elevation of the Lakes. If after such a season a summer follows when there is a small degree of sunshine, the amount of evaporation being thus diminished, the Lakes remain at a high point. These causes, though perhaps satisfactory, and without doubt true, at least to a certain extent, do not always appear sufficient to account for the fluctuations which have been noticed. Twenty-five or thirty years ago the beach of Lake Erie was a travelled highway beyond Buffalo; but at this time it would be quite impossible to travel along the same. . . .

* See Hall's Geology of New York, pp. 408 to 410.

"From the united testimony of persons residing along the margins of all the Lakes, and from other demonstrative proofs, it appears that for many years previous to 1838, all the Lakes had been rising, that about that time they attained their maximum, and have since (to 1842) been subsiding. I have no means of determining the time or degree of the minimum depression. Mr. Higgins, the State Topographer of the Geological Survey of Michigan, gives the rise of the Lakes as five feet from 1819 to 1838, and regards it as probable that the minimum period continues for a considerable length of time, while the maximum continues only for a year. . . A single individual has informed me that about 1788 or 1790 the Lakes were nearly as high as in 1838. . . .

"The *annual* fluctuations in the level of the Lakes are doubtless due to the nature of the seasons, depending on the quantity of rain and snow, and the amount of the evaporation; but it is not so satisfactorily demonstrated that for a series of twenty years the quantity of rain and snow has increased, or that evaporation has lessened uniformly throughout that period.

"The effect of winds in producing (*daily*) temporary elevations and depressions is very remarkable. A strong westerly wind will raise the water in the eastern end of Lake Erie several feet in a few hours, when a much larger quantity is driven down the Niagara; and although so rapid a stream below the Falls, the water frequently rises fifteen or twenty feet during a westerly wind. At the same time the water is diminished at the western extremity of the Lake, and a corresponding depression there takes place. The prevalence of a strong easterly or northerly wind in the same way drives the waters to the western and southern parts of the Lake, and a much smaller quantity flows down the Niagara during such period. The same effects take place in a greater or less degree in all the Lakes—the rising at one extremity and the sinking at the other, till the wind subsides, when it resumes the equilibrium, and in so doing presents a beautiful exhibition of the long swells which are observed in the ocean after the subsidence of a high wind."

Professor Hall was well seconded by Professor Mather, afterwards chief director of the Geological Survey of Ohio, and subsequently (in 1845, '46, and '47) a resident on the shores of Lake Superior, observant of the meteorology and change of level of that Lake, from whose reports and other writings I extract the following particulars respecting Lakes Erie and Superior:*

"A tradition exists that there is a periodical rise and fall in Lake Erie, through a certain number of years. If it is true—and there are reasons for believing that it may be so, to a certain extent—

* See Geological Report of Professor Mather for 1838.

it is evident that the present rise (1838) is higher than has occurred for many years before, for extensive tracts of forest are now overflowed, and timber killed in consequence, the trees of which indicate a long period of growth. The causes that may concur to produce such a variation in the level of the Lake are :—1st, An obstruction to the drainage to the usual quantity of water, in consequence of which, if the usual supply continues, the water must rise. 2d, The increased or diminished supply of water, dedependent on the wetness or dryness of the season, the relative temperature, and amount of evaporation, both from the surface of the Lake and the country which receives its drainage waters, and the amount of water supplied by the Lakes above, as Lakes Huron, Michigan, and Superior,—the amount of water contributed by which is due to the same general causes, with the possible addition of an increasing water-way from the cutting down of their outlets, and pouring down an additional supply. 3d, Another possible cause may be taken into account in the varying level (or upheaval) of the solid earth itself—examples of which are mentioned in various works on geology, as to be seen in part of the coast of Sweden, where it is said to be slowly rising at the present time."

To this the Professor well adds ;—"It is considered an object of great importance to determine what are the *causes* of this effect ; and it was therefore intended, if the Legislature had made an appropriation corresponding to the estimate, and with provisions to the Bill which was reported last Session, *to have set in train a series of observations in several localities on the Lake coast*, and in different parts of the States, so that by the period for the close of the survey, a determination of the causes of the rise and fall of the Lake might have been attained. All the aid which the various branches of meteorology could have secured would also have decided the question as to the small *tides*, which are said to be very sensible in some places."

To the foregoing remarks of Professor Mather, I may be permitted to add that it is much to be regretted that any circumstances should have prevented his excellent suggestion from being carried into effect ; but that such having unfortunately been the case, it now remains for the *British* province of Canada to have the credit of completing so desirable a work, on a far more extended scale.

Turning again to Lake Superior, I am happy to be able to quote the following (abridged) remarks by the same writer :*

"The great rise and fall of the level of the waters of the great Lakes, through a series of years has been long noticed. The cause is doubtless due to a greater quantity of snow and rain, or

* See Report of Geological Survey of Ohio for 1838-39 ; and an article in the American Journal of Science for July, 1848.

of a lower mean temperature and diminished evaporation during the period of rise, and the reverse during the time of fall of the water-level. During 1838–39, the waters were higher than they had been before for at least two centuries. This is demonstrated by the large tracts of land that were inundated which were covered with forest trees, many of them the growth of ages. These trees were destroyed by the overflow around Lakes Erie and Huron, and on the Ste. Marie river, between Point Detour and the Sault Ste. Marie.

"We have no accounts of Lake Superior at that time; but there are facts that indicate a marked variation within a few years. In 1845 a rock in the middle of the entrance of Eagle Harbor, showed itself only in the trough of the waves; and the narrow outlet between the west end of Porter's Island and the main land at Copper Harbor, was of such depth that loaded boats could enter without touching the rocks. In 1846, the rock at the mouth of Eagle Harbor was one-and-a half feet above water; and boats could not get into Copper Harbor. In June, 1847, the rock above-mentioned was still more above water, and the outlet to Copper Harbor could be crossed by stepping on the projecting points of the reef, without wetting the feet; and during some depressions of the water by barometrical waves, it was laid almost entirely dry. From the 18th of June to the 6th of September there was a rise of full twelve inches. It has been observed on this lake that the water is lowest in spring and highest in autumn. This is readily explained by the fact that in winter most of the ordinary supplies of water from the drainage of the surrounding country are cut off, by being converted into ice and snow; while evaporation from the surface of the Lake by the dry northern winds continues to carry away a very sensible quantity of water. During the spring, on the contrary, the snow and ice melt, and the accumulated stores of winter flow into the Lake in greater quantity than to compensate for the evaporation and the drainage at the outlet. . . During a century past the waters of Lake Superior cannot have been more than four feet above the level of 1847, for any considerable time, as is evident by the growth of trees of two feet in diameter at Porter's Island, which would have died had the ground around them been inundated for any great length of time..

To descend once more to Lake Erie. I am next indebted to Col. Whittlesey, Topographer to the Geological Survey of Ohio for the following, confined to the annual and daily fluctuations in that Lake, with a variety of other acceptable details respecting particular sudden floods, as well as for a concise but imperfect tabular view of the *reported*, combined with the *known* annual variations in the level of its waters from 1796 to 1838.*

* See Colonel Whittlesey's Report for 1838–39.

"The general belief among navigators and residents on the Lakes appears to be uniform against the existence of any law by which these fluctuations are governed or may be predicted. The scanty information collected tends to the conclusion that these general elevations and depressions are *fortuitous*, and the result of accidental disorder in the seasons throughout the Lake country. It is, however, well established that there *is* in Lake Erie an *annual* tide, independent of the general state* of the water, which rises from eight to fifteen inches in the mean. The minimum occurs about the time of the breaking up of the ice, late in winter. and the maximum late in spring or early in summer and fall. In the winter less change is perceptible; but early in spring it rises very fast, and with great regularity, till it reaches the maximum. All measurements should be taken subject to this change; but I am unable to fix a mean surface for the year, or to give a probable error. . . The geographical position of Lake Erie in reference to the prevailing winds is the cause of irregularities in the *annual* rise and fall of the waters. Its general course being northeast and southwest, discharging at the north, the steady west wind of the fall accelerates the flow of water from this Lake, at the same time retarding its supply from the other lakes.

"It has been asserted that there exists in the Lakes, as in the Ocean, a daily or *lunar* tide. Whether it is true when applied to Huron, Ontario, or other lakes, *is not perhaps entirely settled.* The observations I have been enabled to make on Lake Erie, and the uniform testimony of the waterman and harbor workmen coincide in denying the existence of any change resembling the oceanic tide, and Mr. Davies, the Collector of Customs, writes decidedly: '*This is not the fact;* the examination of the tide-waiter kept at our office, and observations made almost hourly since August last, enable me to assert, without fear of contradiction, that there is no tide upon Lake Erie.'"

It will be perceived that I already happen to possess more accumulated information on the vicissitudes of Lake Erie, to which my own attention and reflections had been more particularly directed, than of all the rest of our great Mediterranean seas put together; and I have now the additional satisfaction of turning to the investigations of my more immediate neighbors, the State Geologists of Michigan, and more especially of their talented chief, the lamented late Dr. Houghton, and his able assistant and topographer, Mr. Higgins.

From the first Report of the former, however, I can only venture to point to the following naked paragraphs, on the change of elevation in the waters of the Lakes, as equally applicable to Canada and to the American States.†

* *Stage* is the word used, meaning "*level,*" I presume.—R. L.

† See Geological Report of Michigan for 1839, p. 20 to 22.

"The great interest which this subject possesses, in connection with our Lake Harbors, as well as with those agricultural interests connected with the flat lands bordering the Lakes and Rivers, may be a sufficient apology for introducing the following facts and reflections upon the subject. An accurate and satisfactory determination of the total rise and fall of the waters of the Lakes is a subject, the importance of which, in connection with some of our works of internal improvement and harbors, can at this time scarcely be appreciated.

"Much confusion is conceived to have arisen in the minds of a portion of our citizens, in consequence of a confounding of the regular *annual* rise and fall to which the waters of the Lakes are subject, with that apparently irregular elevation and subsidence which only appears to be completed in a series of years; changes that are conceived to depend upon causes so widely different, that, while the one can be calculated with almost the same certainty as the return of the seasons, the other can by no means be calculated with *any* degree of certainty.

"It is well known to those who have been accustomed to notice the relative height of the water of the Lakes, that during the winter season, while the flow of water from the small streams is either partially or wholly checked by ice, and while the springs fail to discharge their accustomed quantity, the water of the lakes is invariably low. As the spring advances the snow that had fallen during the winter is changed to water, the springs receive their accustomed supply, and the small streams are again opened, their banks being full in proportion to the amount of snow which may have fallen during the winter, added to the rapidity with which it may have been melted. The water of the Lakes, in consequence of this suddenly increased quantity received from the immense number of tributaries, commences rising with the first opening of the spring, and usually attains its greatest elevation—at least in the upper Lakes—sometime in the month of June or July. As the seasons advance, or during the summer and a large portion of the autumnal months, evaporation is increased, and the amount of water discharged by the streams lessened, in consequence of which the water of the Lakes falls very gradually until the winter again sets in, when a still greater depression takes place, from the renewed operations of the causes already mentioned.

"The *extreme variation* in the height of the water from winter to summer is subject to considerable change, according as the winters may vary from cold and dry to warm and wet; but during the past eight years it may be estimated at two feet.

"The annual rise and fall of the waters of the Lakes, dependent, as it manifestly is, upon causes which are somewhat uniform in their operation, must not be confounded with that elevation and depression to which the waters are subject, independent of causes connected with the seasons of the year. These latter changes, which take place more gradually, sometimes undergoing but little variation for a series of years, are least liable to be noticed, unless they be very considerable; but with respect to *consequences*, they are of vastly more importance, since they are subject to a larger and more permanent range.

"That the waters of the Lakes, from the earliest settlement of the country have been subject to considerable variation in relative height is well known. At one time the belief was very general that these changes took place at regular intervals, rising for a space of seven years, and subsiding for a similar length of time: a belief which would appear to be in consonance with that of the Indians, and with whom, it no doubt originated. It is not wonderful that a subject, the causes of which are so little comprehended by our natives should be invested with an air of mystery, or that an error once propagated, in consequence of the long series of years required to bring about any considerable change could scarcely be eradicated. While the idea of that septennial rise and fall must be regarded as founded in error, it is nevertheless true, that from the earliest records, the height of the Lakes has been subject to a considerable variation, usually rising very gradually and irregularly for a series of years, and after that falling in a similar, but more rapid, manner."

Dr. Houghton concludes a number of other excellent elucidatory remarks by observing, with regard to the succession of previous cold and wet seasons which produced the great *rise* in 1838 —that, "when we take into consideration, in connection with the causes enumerated, the *fact* that during the wet years evaporation must have been less than during the dry ones, it may be fairly presumed that sufficient apparent causes have existed to produce all the results noticed; and we may add, should such a succession of dry and warm seasons follow, we may look with certainty for a return of the Lakes to the former low level."

In consequence of the great length of the foregoing quotation, I must be content with giving only the following abridged and disjointed particulars on the same subject from Mr. Higgins's Reports of 1839 and 1841:—"That interesting question, the periodical rise and fall of the Lakes, has given rise to a variety of curious speculations. The inference drawn from the following data, is presumed, will not be altogether inconclusive. Calculations may be made sufficiently accurate to determine nearly the amount of surface drained; and if our climate, as is alleged, shows a successive series of cold and moist years, and of warm and dry ones, mutually following each other, variations in the volume of water cannot but be great. Taking into account only the central and upper divisions of the St. Lawrence valley, from Niagara to the northwest angle of Lake Superior, embracing all the country whose streams are tributary to the Lakes, the surface drained is calculated (as shewn by a table of sections) at 248,775 square miles, besides 86,760 square miles occupied by the Lakes; and it is further calculated that the enormous accumulation of water discharged through the River Detroit during high floods, allowing a current of only one mile an hour, is not less than 95,135,000 cubic feet per hour, or 1,585,558 cubic feet per minute. The floods on Lake Ontario, however, are generally the highest by about two feet; and for this obvious reason, that it receives the successive accumulations of all the Lakes, from the Niagara to the St. Louis Rivers, at the head of Lake Superior.

According to Mr. Mather's report for 1841, which is the next testimony to be adduced: "The preceding year (1840) was the second since the unusual elevation of the waters of the Lakes, since which time there had been a remarkable coincidence in the ratios of subsidence, the more unlooked for when taken in connection with the causes which tend to equalize the amount of falling water in the form of rain, snow and dew, with the constant action of evaporation." * * * * *

"The diminution in a given quantity of water exceeds by evaporation all the supplies which it receives from rain—*i. e*, the average amount of falling water is equal per year to thirty-three inches; but the evaporation will reduce it to forty-four inches, when fully exposed to the sun and air. One season of extreme drought would, upon the expanse of these Lakes produce an extreme depression, while the contrary would produce a corresponding rise. It cannot then be matter of much astonishment that such expanded areas of water, subject to such influences should be greatly affected. The wonder is that they do not oftener present greater fluctuations. The equal and almost unvarying stage at which we find them is due to the conformity of the seasons, and the systematic order in which nature conducts all her works.

"The *semi-annual* alterations observable in summer and winter arise from other well known causes. In summer the supply is unchecked, and the consequence is an increase to the height of about thirty inches; when in winter these supplies are again checked, a consequent depression follows. Measures to ascertain exactly the semi-annual fluctuations have never been thought neccessary. *Besides it is not uncommon for ice in large bodies to collect at the outlets of the Lakes, and for a time prevent the usual discharge, as was the case at the outlet of Lake Huron in connection with a west wind in* 1824 *and* 1831, *when the depth in the Detroit River opposite the City of Detroit was diminished over ten feet.*" * * * * *

"Besides all this, the effect of winds acts sometimes in favor as well as against the other irregularities. The geographical position of the Lakes is such, that allowing them to prevail from the same point at the same time over them all, *which is by no means always the case*, they produce a variety of results. A west wind forces the waters of Lake Erie into the Niagara River, at the same time that the waters from the foot of Lakes Huron and Michigan are forced into the straits of Michilimackinac, and there again are met by the waters of Lake Superior, through the straits of Ste. Marie. Hence the straits which connect Lakes Huron and Erie have all the indications of a tide, though irregular as to time, as well as to the amount of its elevation and depression; and it has often both risen and fallen in about the same proportion and sometimes in the same periods as the lunar tides of those Rivers which empty into the Ocean. But when even these tides take place, either in the Lakes themselves, or in the straits connecting them, they are fortuitous, and the results of accidental disorder common throughout the Lake region. Another feature may be observed in the Lakes, differing in nothing from the ground swell of the Ocean—the reaction of the water, after having been pressed by the wind a few days or hours in one direction;—the most favorable point for noticing which is at an outlet or bay, and Lake Superior having the largest surface presents the most favorable traits of such reaction."

Having thus nearly exhausted my scattered extracts and notes, derived from American authorities, it now remains to refer to a few more memoranda on the same interesting subject, derived from British writers, such as Sir Richard Bonnycastle, Mr. McGregor, Mr. Talbot and others. Among these I turn first to Sir Richard's work on Canada, from which I have taken the following disjointed extracts.*

"The Lakes of Canada have not engaged that attention *at home*, which they ought to have done; and there is much information about them which is a dead letter in England. Their rise and fall is a subject of great interest. The great sinking of their levels of late years, which has become so visible and injurious to commerce, deserves the most attentive observation. The American writers attribute it to various causes; and there are as many theories about it as there are upon all hidden mysteries. Evaporation and condensation, woods and glaciers, have all been brought into play. If the Lakes are supplied by their own Rivers, and by the drainage streams of the surrounding forests; and all this is again and again returned to them from the clouds, whence arises the sudden elevation or the sudden depression of such enormous bodies of water which have no tides? * * * Where do the Lakes receive that enormous supply which restores

* See Bonnycastle's Canada in 1840, pp. 276, 291 to 300.

them to their usual flow? or are they permanently diminishing? I am inclined to believe that the latter is the case, as cultivation and the clearing of the forests proceed; for I have observed within fifteen years the total drying up of streamlets since the removal of the forest; and these streamlets had evidently once been rivulets, and even rivers of some size, as their banks cut through alluvial soils plainly indicate. * * * Perhaps, whenever a *cycle* of years occurs, in which the northeast wind prevails during a year, or a series of years, the Lakes lose their level; for the direction being northeast by southwest such is the usual current of the air, and therefore either northeast or southwest winds are the usual ones which pass over the surface. Whenever southerly winds prevail,—and in the cycle of the gyration of atmospheric currents this is certain, and will be reduced to calculations,—the great Lakes are filled to the edge; and whenever north and northeasterly winds take their appointed course, then these Mediterraneans sink, and the valley of the Mississippi is filled to overflowing. * * * But the most curious facts are that the different Lakes exhibit different phenomena: the Board of Works of Ohio having stated that in 1837–8, the water descending from the atmosphere did not exceed one-third of that which was the minimum of several preceding years.

"Ontario, from the reports of professional men, has varied not less than eight feet; and Erie about five. Huron and Superior, being comparatively unknown, no dates are afforded to judge of them. But what vast atmospheric agencies must have been at work when such wonderful results on the smaller Lakes have been made evident!"

"*What a useful thing*," further observes Sir Richard, "*it would have been, if scientific navigators, or resident observers had registered the rise and fall of the Lakes in the years since Canada came into our possession.*"

Among other unconnected notes I find also some judicious remarks, extracted from McGregor's British America;* but from these I must be content to quote only the following, as referring to a collateral philosophical question of deep interest which may perhaps be touched on in the sequel; namely, the possibility of there being a subterraneous outlet to some of the great Lakes—a hypothesis which I have long been disposed to regard as not altogether irreconcilable with the geological formation of the basins of the middle and lower lakes, though perhaps not so with the structure of the Lake Superior regions; it being doubted whether, notwithstanding the great annual evaporation, the volume of water discharged by Lake Erie *does* sufficiently account for the vast united supply received by it from the immense triple resources of Lakes Superior, Michigan and Huron.

* See McGregor's British America, vol. i, pp. 131 to 133.

"As the temperature of the climate in America depends chiefly on the winds, the formation of that continent is evidently the cause of the frosts being more intense than in countries in parallel latitudes in Europe; a consequence arising principally from the much greater breadth of America towards the poles. Winds change their character in America. Northeast winds, which are cold and dry in Europe, are wet and truly disagreeable in America. Northwest winds are, on the contrary, cold and dry, and are frequent during winter in America, much about the same period that northeasterly winds prevail in Europe. One great, if not the principal, cause of cold in America, is the direction of the mountainous ranges and basins of country which conduct or influence the course of the winds. While the sun is to the south of the equator, the winds less under solar influence prevail from the northwest, following, however, the great features of the continent. The winds blowing over the vast regions of the north are always piercing and intensely cold. The return of the sun, again, by the diffusion of heat, agitates the atmosphere and alters the winds, which blow from a contrary direction, till the equilibrium is produced. This, however, does not appear to require much time, as no wind blows scarcely forty hours together from any one point.

"The comparative depths of the Lakes forms another extraordinary subject of enquiry. The bottom of Lake Ontario, which is 452 feet deep, is as low as most parts of the Gulf of St. Lawrence, while Lake Erie is only 60 or 70 feet deep; but the bottoms of Lakes Huron,* Michigan and Superior, are all, from their vast depth, although their surface is so much higher, on a level with the bottom of Lake Ontario. This is certainly not impossible; nor does the discharge through the Detroit river—allowing for the full probable portion carried off by evaporation—appear by any means equal to the quantity of water which the three upper great Lakes may be considered to receive. All the Lakes are estimated to cover 43,040,000 acres. The great Lakes occasionally rise above their usual level from three to five feet. These overflowings are not annual nor regular. They have occurred about once in seven years, and are probably the effect of more rain and less evaporation during the seasons in which they take place. Sir George Mackenzie observed occasional overflowings of two to three feet in the Lakes northwest of Lake Superior; so that they are not peculiar to the Lakes of the St. Lawrence."

Having at length nearly exhausted my miscellaneous quotations and notes, I propose concluding that main branch of my task with the following appropriate remark, derived from a note

* As an instance of our ignorance of the true depth of some of our Lakes, it is proper to note here that that of Lake Huron has, after all, been lately ascertained by the American Coast Survey to be not more than 420 instead of 860 feet!—R. L.

at page 133 of the 1st volume of Talbot's Canada, as not only bearing on the now generally admitted influence of prevailing winds on the temporary fluctuations in the level of the Lakes, but also as adverting to the almost equally demonstrable fact, that the singular *severity* of our Canadian winters, and more particularly those of Lower Canada, compared with European countries in the same parallels of latitude, is altogether uninfluenced by the vast extent of our Lakes; on which subjects the author referred to, quoting an American author, states as follows:—

"Professor Dwight has proved that the height of the river (Niagara) both above and below the Falls, depends on the quarter from which the wind blows. Lake Erie, he says, is regularly raised at the eastern end, where the Fall commences, by every wind blowing between northwest and southwest. A strong westerly wind elevates its surface six feet above its ordinary level. The rivers must, of course, be proportionally elevated; and at the outlet must, when such a wind blows, be six feet higher than the *usual* water mark. * * On the contrary, when the wind blows from the northeast (the only easterly wind which in this region is of any importance), the waters of Lake Erie must recede of course, and fall considerably below their usual level, and the river be necessarily lower than at any other time."

The same author, in another part of his work (pp. 339 to 342), remarks as follows, with regard to the climate of Canada differing from that of European countries in a similar latitude:

"The cause of this phenomenon appears to have eluded the most diligent and profound research. Many writers attribute the severity of the winter to the astonishing prevalence of northwest winds, and the amazing extent of the Lakes. That the severity of the weather in winter cannot with any propriety be attributed to the influence of the Lakes will appear evident to every man who reflects that the shores of those great inland seas enjoy a much milder climate than any other part of the country in the same parallels of latitude, however remotely situated from them. Fruit trees thrive well and bring their fruits to great perfection along the northwest extremity of Lake Ontario, in lat. 43 deg. 30 min., and along the north shore of Lake Erie; and yet at 35 miles from the latter place, and in lat. 42 deg. 20 min., this fruit cannot be cultivated; and I have also seen snow three feet in depth a degree south of Lake Ontario, while at the same time it did not exceed six inches in the immediate vicinity of that Lake."*

(*To be continued.*)

* See the letter introductory to my late paper on the establishment of a system of meteorological observations; and also the note at the foot of page 293 of this Journal.

ART. XVII.—*On the Clinochlore of Achmatowsk;* by N. von KOKSCHAROV.*

THE green mineral of Achmatowsk, remarkable for its dichroism and its perfect cleavage, was for a long while regarded as identical with the chlorite of Werner. Von Kobell† first remarked the difference from that species of both the Achmatowsk chlorite and another of like characters from Schwarzenstein, and gave to them the name *ripidolite* (from ῥιπις, *feather* and λιθος *stone*). G. Rose, observing that the name ripidolite was more appropriately descriptive of Werner's mineral than of that of Achmatowsk, reversed the use of the names ripidolite and chlorite, giving the former to the St. Gothard and Rauris mineral and the latter to von Kobell's ripidolite. Recently, a mineral from Westchester, Pa., has been described by W. P. Blake, as Clinochlore, which is not different from the Achmatowsk species.

The crystals of Achmatowsk according to von Kobell are hexagonal. All other mineralogists have adopted this view. At the suggestion of my esteemed instructor, G. Rose, I made in 1851 many measurements of the crystals, and in my paper I also described it as hexagonal.‡

[The author here observes that his former measurements were made with great care with the reflective goniometer; and that although discrepancies with calculation were observed, and the planes were not always simple in their crystallographic signs, the habit of the crystals appeared to be hexagonal, and this view was hesitatingly adopted. He then proceeds, as follows.]

The observations on my labors of G. Rose and M. Kenngott, and especially a letter from J. D. Dana giving a description of the Clinochlore and its analysis by Mr. Craw, led me to suspect that the crystallization of the Achmatowsk chlorite was *monoclinic.*§

As the Achmatowsk mineral has now proved to be monoclinic and its name has been the occasion of some perplexity in the science, I propose to retain the name Clinochlore for the species, including with it also the Schwarzenstein mineral; and I have consequently placed this name at the head of this article.

* Read before the Akademie der Wissenschaften zu St. Petersburg, Sept. 20, 1854, and published in volume xiii. of their Memoirs.

† Jour. f. pr. Chem., xvi, 470, 1839.

‡ Verhandl. der K. K. Min. Ges. St. Petersb., 1850 and 1851, p. 163, and Pogg. lxxxv, 519.

§ [The notes in the original giving the remarks of G. Rose, and Kenngott, and an extract from the letter of J. D. Dana, are here omitted.—EDS.]

The clinochlore of Achmatowsk is a very beautiful mineral species. It accompanies handsome crystallized varieties of garnet, diopside, apatite and other species, in which this locality is so very rich. Many of the crystals are tabular, while others are lengthened in the direction of the vertical axis, and often they are in druses. A large part of the crystals are unfit for measurement by the reflective goniometer; but there are some small ones which afford good results. The planes observed are as here enumerated.*

O (P)			
$\frac{2}{3}$-∞ (*y*)	$\frac{2}{3}$ (*n*)		
	$\frac{3}{4}$ (*m*)		
1-∞ (*i*)	1 (*o*)		
		$\frac{3}{2}$-$\grave{3}$ (*s*)	
		2-$\grave{3}$ (*c*)	
			3-$\grave{\infty}$ (*k*)
4-∞ (*z*)			4-$\grave{\infty}$ (*t*)
	∞ (M)	∞-$\grave{3}$ (*v*)	∞-$\grave{\infty}$ (*h*)
	−6 (*d*)	6-$\grave{3}$ (*w*)	
−4-∞ (*x*)			
	−2 (*w*)		

Observed Planes.

The most important combinations are as follows:

I.—0, −4-∞, $\frac{2}{3}$, 1, ∞, $\frac{3}{2}$-$\grave{3}$, 4-$\grave{\infty}$.

II. (fig. 1)—0, $\frac{2}{3}$-∞, 1-∞, −4-∞, $\frac{2}{3}$, 1, −2, $\frac{3}{2}$-$\grave{3}$, 4-$\grave{\infty}$.

III. (fig. 2)—0, 1, ∞, 4-$\grave{\infty}$, ∞-$\grave{\infty}$.

IV. (fig. 3)—0, 1-∞, −4-∞, $\frac{2}{3}$, 1, ∞, $\frac{3}{2}$-$\grave{3}$, ∞-$\grave{3}$, 4-$\grave{\infty}$, ∞-$\grave{\infty}$.

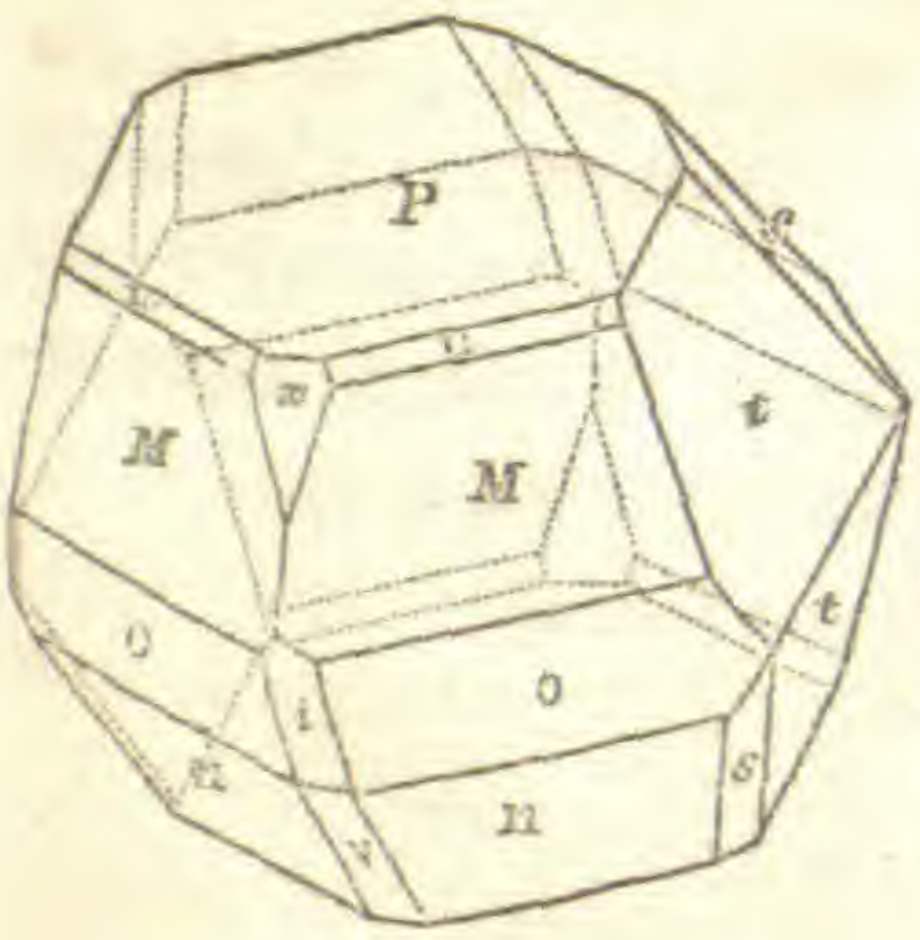
V.—0, $\frac{2}{3}$, ∞, 4, $\grave{\infty}$.

VI.—0, $\frac{2}{3}$, 1, ∞, 4-$\grave{\infty}$, ∞-$\grave{\infty}$.

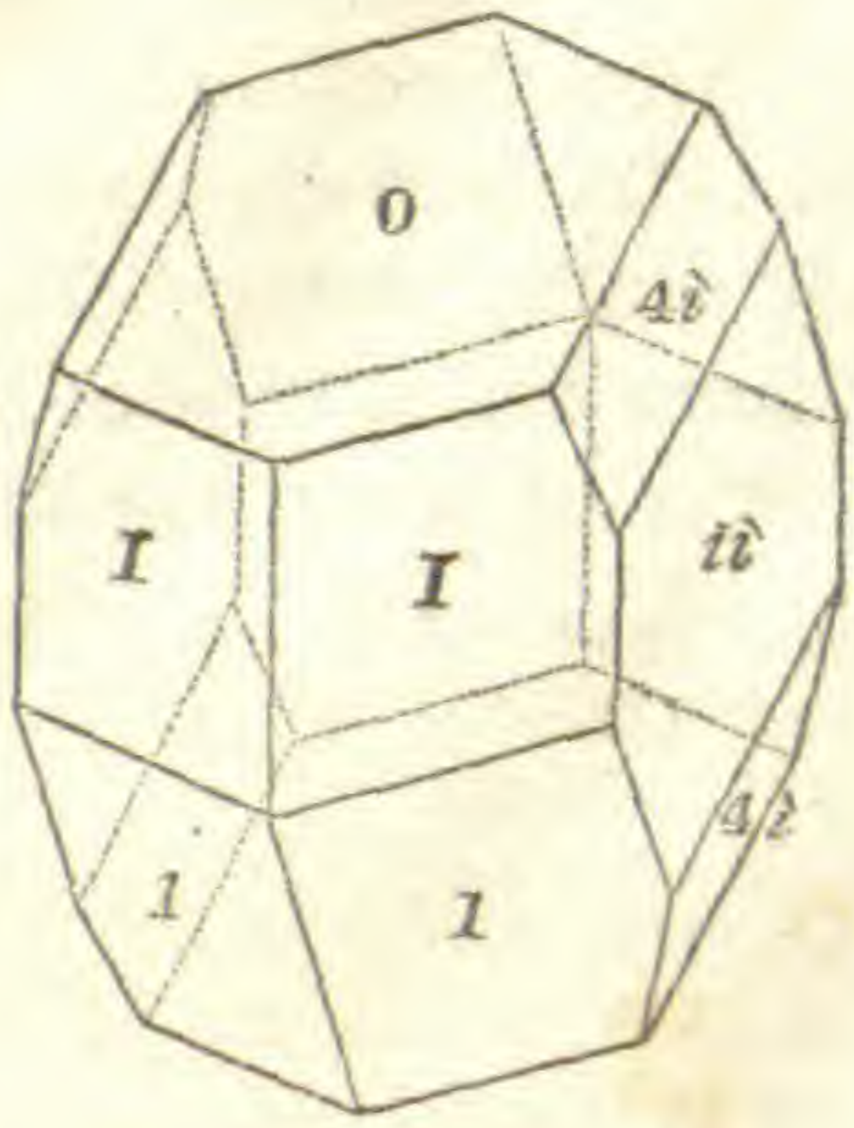
VII.—0, $\frac{2}{3}$-∞, 1-∞, 4-∞, $\frac{2}{3}$, ∞, 2-$\grave{3}$, ∞-$\grave{3}$, −6-$\grave{3}$, 4-$\grave{\infty}$.

VIII.—0, 1-∞, 4-∞, 1, ∞, 2-$\grave{3}$, ∞-$\grave{3}$, 4-$\grave{\infty}$.

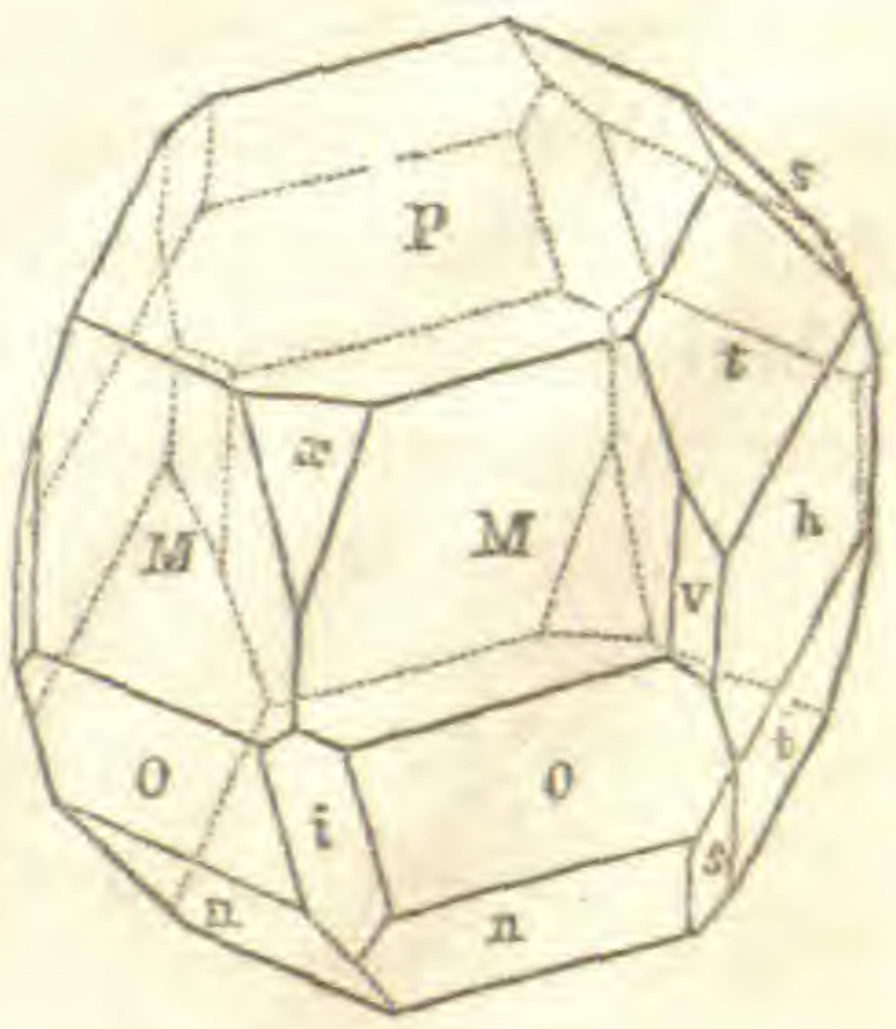
1.



2.



3.



Putting *a* for half the vertical axis, *b* for half the clinodiagonal, c for half the orthodiagonal, and C for the inclination of the vertical axis or *a* on *b*.

[* The planes are here presented in a table according to the method of J. D. Dana, showing the several zones of planes; the 1st column being the zone parallel to the orthodiagonal; the 2nd, the fundamental zone; the 4th, that parallel to the clinodiagonal. The symbols are essentially Naumann's, except that the letter P is dropped. The letters used by Kokscharov on his figures are also given.—Only part of the figures of the memoir are here copied. In figure 2, the lettering is altered, to correspond with the notation, only *i* is wiritten for ∞; O, I, 1, 4*i*, *ii* are respectively P, M, o, t, h, of Kokscharov.—D.]

Also, μ for the inclination of the clinodiagonal terminal edge on the axis a; ν, for the same on the diagonal b; ϱ, for the inclination of the orthodiagonal, terminal edge on the axis a; X, for the inclination of a face of P on the clinodiagonal section; Y, ibid on the orthodiagonal section; Z, ibid on basal section.

And also: X′, Y′, Z′, and μ', ν', for the corresponding angles in the negative hemipyramid:—we then find

$$a:b:c=1{\cdot}47756:1:1{\cdot}73195^{*} \qquad C=62^\circ\ 50'\ 48''$$

$X=60^\circ\ 44'$	$Y=48^\circ\ 53'$	$Z=77^\circ\ 54'$
$X'=70^\circ\ 22'$	$Y'=31^\circ\ 10'$	$Z'=42^\circ\ 12'$
$\mu=41^\circ\ 4'$	$\nu=76^\circ\ 5'$	$\varrho=49^\circ\ 32'$
$\sigma=60^\circ\ 0'$	$\mu'=24^\circ\ 42'$	$\nu'=38^\circ\ 8'$

The angle σ being 60°, therefore the plane angles of the basal planes are 120° and 60°, or when the acute angle is replaced, a regular hexagon. This hexagonal character is also strongly shown in the planes of the zone m-3, whose intersections with the edges of the basal plane are 150°, and which correspond to the zone m-2 (or intermediate hexagonal pyramids and prisms) of the hexagonal system. The compound crystals consisting of three crystals, which are common in the clinochlore of Achmatowsk, have a still greater similarity to a hexagonal prism.

It is also to be observed that the angle C, 62° 51′, is nearly half the angle of M : M, or 125° 37′—half of 125° 37′, being 62° 48½.

In the crystals, the hemipyramids of the fundamental series are mostly more or less striated parallel to their intersection with P(0), and seldom smooth and shining so as to afford good measurements. The faces of the clinodiagonal zone m-$\bar{\infty}$, are rather smooth and lustrous; but the face P, and the planes of the zone m-$\bar{3}$ are the brightest and smoothest. The following angles are obtained by calculation from the values of the axes given, excepting those with an asterisk which are measured angles:

oP 102° 7′ (102° 6′†)	*mm* 125° 24′	*sh* 140° 39′
oM 143° 57′	*mM* 132° 35′	*cP* 107° 26′
on 163° 34′	*uP* 127° 43′	*cn* 150° 20′
ot 122° 0′	*uM* 166° 14′	*ct* 151° 28′
ou (over M) 130° 10′	*ux* 155° 49′	*cv* 148° 11′
oo (over *i*) 121° 28′	*ut* 124° 33′	*cw* (over *v*) 138° 30′
oh 119° 16′	*uh* 113° 18′	*wP* 114° 4′
nn (over *y*) 127° 53′	*uu* 133° 24′	*wM* 152° 38′
nP 118° 32′ (118° 28′†)	*dP* 118° 59′ (119° 5′†)	*wt* 151° 29′
ny 153° 57′	*dM* 174° 58′	*wh* 142° 15′
nM (over *o*) 127° 31′	*dt* 124° 33′	*wv* 170° 19′
nt 124° 31′ (124° 31′†)	*dh* 115° 56′	*wn* 119° 59′
mP 113° 28′	*dd* 128° 7′	*wo* 133° 27′
mi 150° 6′ (150° 0′†)	*st* 151° 5′	*MP* 113° 57′ (113° 57′†)
mh =117° 18′	*sn* 153° 26′	*Mt* 124° 8′ (124° 4′†)
mt 124° 4′	*so* 148° 16′	*Mh* 117° 12′
mk 125° 27′	*sP* 116° 45′	*MM* 125° 37′ (125° 38′†)

* Obtained from the measured angles; M : M = 125° 37′; M : P = 113° 57′; P : o = 102° 6½′.

† Observed angles.

vP 75° 37′
vM 150° 10′
vt 150° 59′
vh 147° 1′
vv 65° 57′
kP 113° 42′
kh 156° 18′
kk (over *h*) 132° 35′

kk (over *P*) 47° 25′
tP 108° 14′
th 161° 46′
tt (over *h*) 143° 33′
iP 103° 55′
io 150° 44′
in 148° 35′
iy 161° 47′

yo 145° 57′
yP 122° 8′
zP 72° 7′
zi 148° 12′
zy 129° 59′
xP 125° 7′ (125° 4′*)
xM 151° 45′

For the forms, X, Y, Z, etc., have the following values:

Form	X	Y	Z	μ	ν	ϱ	σ
$\frac{2}{3}$	63° 57′	62° 41′	61° 28′	59° 17′	57° 52′	60° 22′	60° 00
$\frac{3}{4}$	62 12	58 19	66 32	53 47	63 23	57 23	60 00
−2	66 42	27 17	52 17	14 37	48 14	30 22	60 00
−6	64 04	26 28	61 01	5 27	57 24	11 03	60 00
$\frac{3}{2}$-3	39 21	78 57	63 15	72 23	44 46	38 00	30 00
2-3̀	34 17	73 17	72 34	59 17	57 52	30 22	30 00
−6-3̀	37 45	53 41	65 56	14 37	48 14	11 03	30 00
∞	62 48½	27 11½					
∞-3̀	32 59	57 1					
3-∞̀	23 42		66 18				
4-∞̀	18 14		71 46				
1-∞		41 04	76 05				
$\frac{3}{8}$-∞		59 17	57 52				
4-∞		9 16	107 53				
−4-∞		7 57	54 53				

Cleavage very perfect parallel with the base. G. = 2·774 according to G. Rose. H. = 2·5. Strongly dichroic, being green in the direction of the vertical axis and brown or hyacinth-red transversely, and the colors seldom so different in other dichroic species. Streak-powder light greenish-white. The largest crystals often only translucent on the edges; the smaller subtransparent. Flexible in thin plates but not elastic.

Although the basal plane is usually smooth and shining, there is in some crystals an unevenness which indicates by its stellate appearance a regular composition. In the crystals of Achmatowsk, this compound structure is quite common; they consist of three simple crystals, compounded parallel to the plane $\frac{3}{2}$. Since the faces of the form $\frac{3}{2}$ are inclined to the clinodiagonal section 60°, and to the basal plane 89° 43′, the three crystals will meet at angles of 60°, and have their basal planes inclined to one another 179° 25′, or very near 180°.† The large crystals are often also made up of a mixture of small crystals with their basal planes grouped in rosettes, as happens in the specular iron of St. Gothard.

* Observed angle.

† It might be suspected from such twins which are like those of Aragonite, that the plane $\frac{3}{2}$P may make an angle of 90° with the base, (as in the mica of Vesuvius); but the appearance of salient and reëntering angles on the cleavage face of these compound crystals seems to be good evidence that the angle between $\frac{3}{2}$P and the base is not a right angle. In the collections of P. von Kotschubey, there is a large druse of Clinochlore crystals in which each is a twin of three crystals. [In twins from Westchester, there is no reëntering angle, the cleavage plane being perfectly smooth.— D.]

According to G. Rose, the Clinochlore of Achmatowsk has the following characters: B.B. on charcoal intumesces, becoming yellowish brown and opaque: in the platinum forceps, fuses with a strong heat on the outer edges to a black glass. In a tube undergoes the same changes as on charcoal giving little water with no fluoric acid. With borax dissolves easily to a clear glass, colored by iron; with salt of phosphorus a similar glass, the silica separating; with soda on charcoal, a brown swollen mass which fuses with difficulty. With sulphuric acid wholly decomposed. Analyses by von Kobell (J. f. pr. Ch. xvi, 470), Varrentrapp, (G. Rose, Reise n. d. Ural, 1842, ii, 127 and Pogg., xlviii, 189) and Marignac (Ann. de Ch., x, 430).

	$\dddot{Si}$	$\dddot{\bar{Al}}$	$\dot{Fe}$	$\dot{Mn}$	$\dot{Mg}$	$\dot{H}$	Insol.
1.	31·14	17·14	3·85	0·53	34·80	12·20	0·85=100·11
2.	30·38	16·97	4·37	——	33·97	12·63	—— = 98·32
3.	30·27	19·89	$\dddot{\bar{Fe}}$ 4·42	——	33·13	12·54	—— =100·25

Varrentrapp deduces the formula,

$$(\dot{Mg}, \dot{Fe})^3 \dddot{Si} + \dddot{\bar{Al}} \dddot{Si} + 2\dot{Mg} \dot{H}^2.$$

This composition does not differ from that of the Clinochlore of Pennsylvania.

I shall have to revise my comparisons of the described chlorites, after this reference of the Achmatowsk mineral to the monoclinic system, with the exception of the Schwarzenstein chlorite (ripidolite of v. Kobell), as they cannot stand, since we do not know to which zone the described planes of these chlorites belong. I may here observe that none of the angles obtained by Frobel and Descloizeaux in Pennine, are yet found in either of the zones of the Achmatowsk chlorite. The same is true of the Kämmererite. The resemblance of the clinochlore crystals to hexagonal forms, renders it desirable that there should be a revision of the crystallography of all these minerals.

The optical characters of our crystals have not yet been fully studied. I can only state that the laminæ of the Achmatowsk clinochlore examined with the tourmaline, allows the light to pass when the axis of the tourmaline plates are at right angles—in which respect it does not differ from biaxial crystals. There is a strong probability therefore, that the optical characters are like those of the Pennsylvania Clinochlore. In this last, Mr. W. P. Blake, examining a triangular plate, found that the two axes lie in the same plane which was at right angles with one side of the triangle; and this plane therefore lies in a clinodiagonal section. According to Blake, one of the optical axes is inclined at an angle of 27° 40′, and the other at 58° 13′, making the angle between them 85° 53′ and 94° 7′.

Mr. Blake has observed in another specimen a second system of axes, the plane of which makes an angle of 60° with the first, which indicates that the specimen was a compound crystal.

[The paper closes with an enumeration of the measurements of crystals of the Achmatowsk Clinochlore with a Mitscherlich's goniomer, by which the angles were obtained. The mean for P : M from 12 measurements of one crystal was 113° 58′; (the extremes 113° 57½′ and 113° 58¾′) from another 113° 56′; from a third 113° 56¼′; giving for the mean of the three 113° 56¾′. For M : M from No. 1, 125° 38′, for No. 2, 125° 37′. For P : o from crystal No. 3, 102° 6½′; from crystal No. 5, 102° 6′; from crystal No. 3, P : n = 118° 28′; from No. 6, P : t = 108° 11′; from No. 2, M : t = 124° 3½; from Nos. 2 and 3, t : n = 124° 32′; from No. 4, 124° 30′; from No. 4, P : x = 125° 4′. From No. 7, P : d = 119° 5′, m : i = 150° 0′.]

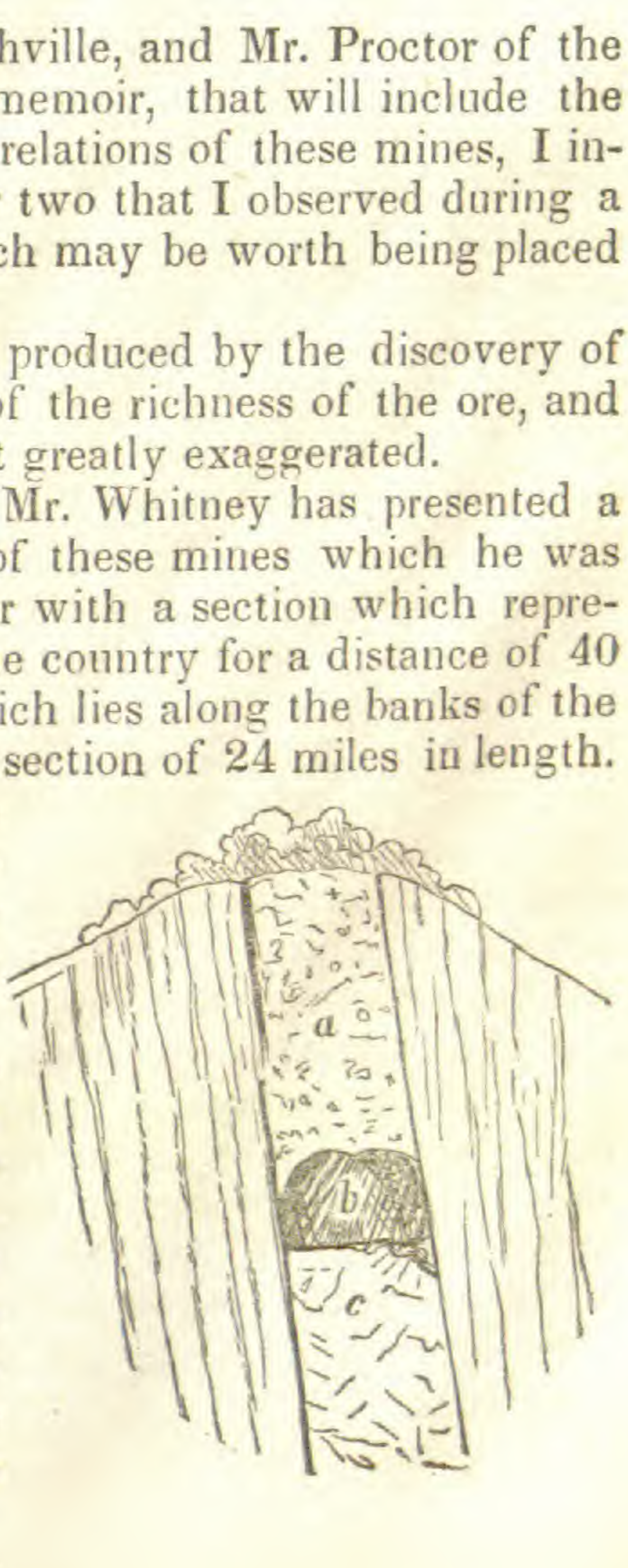
Art. XVIII.—*A brief notice of some facts connected with the Duck Town, Tennessee, Copper Mines;* by M. Tuomey, State Geologist, Ala.

Knowing that Dr. Curry of Nashville, and Mr. Proctor of the Tennessee Mines, are preparing a memoir, that will include the history, geological and economical relations of these mines, I intend to confine myself to a fact or two that I observed during a hurried visit to the place, and which may be worth being placed upon record.

Notwithstanding the excitement produced by the discovery of these mines, the current accounts of the richness of the ore, and great thickness of the beds, are not greatly exaggerated.

In a short but very lucid report, Mr. Whitney has presented a clear view of the state of some of these mines which he was commissioned to examine, together with a section which represents the geological character of the country for a distance of 40 miles. The road to the mines, which lies along the banks of the Ocoee river, exposed an admirable section of 24 miles in length.

The mines are situated at the junction of the silurian and metamorphic rocks,—or as Mr. Whitney suggests, the cupriferous slates may be altered silurian strata.



The accompanying cut presents the position, and relation of the metalliferous beds at all the mines: *a*, upper portion of the bed composed of a porous, amorphous mass of red and brown oxyd of iron, the *gossan* of the Cornish miners, *iron hat* of the Germans, which is the residue of the ore after the copper has been dissolved out. This process, the solution of the ore, is constantly, though, of course, slowly going on, as may be seen at the works, and hence the very variable thickness of the ore *b*. From portions of the bed every trace of copper has disappeared, down to *c*. The copper ore *b*, is a bluish black altered sulphuret. That the alteration is due to heat is rendered highly probable by the vesicular structure of the ore itself, as well as by the joints with which it is intersected, and which correspond in direction with those of the surrounding rocks of the country.

In every published account of these mines that I have seen, the impression is left, that the ore *b* is derived from the underlying portion of the bed *c*, by decomposition. Now *c* has been reached in all the mines, and invariably consists of arsenical iron, with rarely more than one per cent. of copper in the form of yellow sulphuret, and consequently could not furnish by decomposition or any other conceivable process, an ore containing 20 per cent. of that metal.

This lower arsenical iron portion *c*, of the bed is found everywhere immediately underlying the black ore, at no great distance below the surface, and is frequently met with even in the levels driven in the hill-side.

The whole of that portion of the bed above *c*, doubtless once consisted of yellow sulphuret of copper, and the part below *c*, as at present, of arsenical iron. During the metamorphism of the slates the sulphuret was altered to the black ore, and subsequently the soluble salts derived from this ore, were dissolved out by the simple process of leaching, the residual *gossan*, or *iron hat* being left in the upper portion of the bed, and the still unbleached ore, resting on the arsenical iron.

It is remarkable that this same arsenical iron with a little copper, is found in some of the shafts sunk, in exploring for copper in Alabama.

The solution of the question, What is below the arsenical iron? is a most interesting subject in connection with the value and future prospects of the mines. At one place a shaft has been sunk in the arsenical iron, to a depth of 10 or 12 fathoms without showing any encouraging change, and at another a shaft has been commenced calculated to cut the bed, 50 fathoms below the present level of the mine, or, as it is called in the mining reports, for the purpose of "proving the yellow sulphuret." These experimental shafts, if continued, will be of the utmost importance to the whole copper region, including portions of Georgia and Alabama. Should this arsenical iron terminate, at a moderate depth, in the yellow sulphuret, then indeed may Tennessee boast of such mines as are not found in the history of mining operations.

ART. XIX.—*On the Periodical Variations of the Declination and Directive Force of the Magnetic Needle;* by W. A. NORTON, Professor of Civil Engineering in Yale College.

THE direction in which the magnetic force of the earth solicits either end of a magnetic needle is ascertained by suspending the needle freely by its centre of gravity. It is well known that throughout the greater part of the northern hemisphere the north end of a needle thus suspended is depressed below the plane of the horizon; and that throughout the greater part of the southern hemisphere the south end is depressed below this plane; also that this *inclination* or *dip* of the needle gradually increases from the *magnetic equator*, where it is zero, in both directions to the magnetic poles, where it is 90°. Such then are the varying directions of the directive force of the magnetic needle at different points of the earth's surface. The two ends or poles of the needle are solicited in opposite directions; the north end downward, and the south end upward. It suffices in discussing the perturbations to which the earth's magnetic force is subject, whether of direction of intensity, to confine our attention to the action upon one end of the needle, for example the depressed end,—(north end in the northern hemisphere, and south in the southern hemisphere); since the repelling force, acting upon the more elevated end, experiences corresponding changes, and has uniformly the same tendency, in giving direction to the needle. If now the directive force be decomposed into two components, the one horizontal, and the other vertical, we have what are called the *horizontal force*, and the *vertical force*, acting upon the needle; or the horizontal and vertical magnetic intensities of the place. These two forces, together with the *declination* (or deviation of the line of direction taken up by the horizontal compass needle, from the true north and south line) constitute what are called the *Magnetic Elements* of the station. Each of these elements changes in value as we pass from one station to another. It is well known also that at any one station they are not at all times unalterably the same; but are subject to variation from hour to hour, from day to day, and from year to year. The changes from hour to hour during the period of a day we call the *Diurnal Variations;* those from day to day, during the period of a year, we call the *Annual Variations;* and the change from year to year, the *Secular Change.* In a more restricted sense we call the entire amount of the change, whether of increase or diminution, in a day, the diurnal variation of the element; and we often attach a similar signification to the term annual variation, of a magnetic element. But, in the present paper I shall generally use these terms in the most comprehensive sense; that is as comprising all the variations that occur during the day, whether we compare them hour by hour, or by longer intervals.

There are two classes of diurnal variations of the magnetic elements—viz, those which are *Periodic* and those which are *Irregular*, or more properly *Occasional*. Thus any one element, as the declination, regularly increases during a certain portion of every day, and then as regularly decreases during another portion of the day. Changes also occur, to all appearance fortuitously, at any hour of the day; so that their occurrence cannot be predicted for any one hour. Still it is now known that the irregular variations, so called, are under the control of certain overshadowing laws; thus they occur more frequently, and are larger in amount at certain hours than at other hours, and at certain parts of the day the liability is to an increase, at other parts to a diminution. If we compare the amount of the declination, or other element, at any hour of the day, with the same at the same hour of the following day, we find that a change has occurred, and if we do the same throughout the year we discover that the element in question, or its amount at a particular hour increases during half of the year, from a certain day, and decreases during the remaining half; in other words, it undergoes a regular variation, the period of which is a year. The amount of the change of the declination, or horizontal or vertical force, that takes place during a day, also varies from one season to another. Besides the periodic variations whose period is a day, or half a day, or a year, there is another class, recently discovered, whose period is about ten years (10 to 11 years). Thus, it is found that the amount of the alternate increase and decrease of the declination during a day is greater some years than others, and that it alternately augments and diminishes during a period of ten or eleven years. It is an interesting and very important fact, in a physical point of view, that this period has been found to be identical with that of a change which has been observed to occur in the number and magnitude of the spots on the sun from year to year, the maximum and minimum of the one quantity coinciding also in point of time with the maximum and minimum of the other quantity. Thus the year 1843 was that in which the mean daily movement of the needle, for the year, was the least, and also that in which the number and magnitude of the solar spots was the least. The year 1838 was the epoch of the previous maximum for both. The changes are very marked; the number of groups of solar spots observed by M. Schwabe during the year 1843 was 34, during the year 1838, 282; the mean daily movement of the needle at Toronto for the entire year, was 8′·90 in 1843, and 12′·11 in 1848, (the year of the following maximum). It has been still more recently established, that the irregular variations, so called, undergo similar changes during the period just mentioned—the *solar period*, as it may be termed, by way of distinction.

It is now about twenty-five years since the project was conceived, by Baron Humboldt, and partially carried into execution, of covering the earth with magnetical observatories, at which "simultaneous observations should be made of every regular and irregular excitement of the earth-force." Since the year 1840, magnetical observatories have been in systematic operation in all parts of the earth, "from Toronto, in Upper Canada, to the Cape of Good Hope, and Van Diemen's Land, from Paris to Pekin;" provided with the magnetometers contrived by Gauss in 1832. These are large magnets delicately suspended, and carrying a small mirror, in which the observer, looking through a small telescope firmly fixed on a stone pier, sees the reflection of the fixed scale, and thus observes with great precision the smallest movement of the magnet. The horizontal force magnetometer is brought by the torsion of its suspension wire into a position at right angles to the magnetic meridian, and shows by its motions the variations of this force. The vertical force magnetometer devised by Dr. Loyd of Dublin, admits of motion only in a plane perpendicular to the magnetic meridian. The bar rests by a knife edge, on agate planes, and is adjusted by a ball moveable upon a fine screw, so as to deviate a little from the truly vertical position. In its improved form it carries a mirror at right angles to the plane of the bar, like the declination and horizontal force magnetometers. With these magnetometers a change of magnetic intensity amounting to the $\frac{1}{40000}$th part is measured. The changes of declination are shown by the declination magnetometer, or declinometer, to within 2″ to 3″ of the truth. In this "net work of stations provided with similar instruments" are especially to be noticed the British Colonial Observatories (at Toronto, St. Helena, Cape of Good Hope, and Hobarton in Van Diemen's Land) which began operations in 1840, and the Russian Observatories scattered over the Russian Empire, which were erected about ten years earlier. Hourly or bi-hourly observations have been made at these and at many other observatories in Europe and elsewhere, for many years; and on certain days, called Term Days, they have been noted as often as every 2½ minutes. We have now several volumes of Reports of the magnetical and meteorological observations made at the British Colonial Observatories, with abstracts, discussions, &c., published under the direction of Colonel Edward Sabine. Annual Reports of the observations made at the Russian Observatories have also been published, under the superintendence of Professor Kupffer. Reports of the observations made at the Girard College Observatory, and also at Washington, under the direction respectively of Professor

Bache, and Lieutenant Gilliss, during the years 1840–1845, have also been published. To separate the regular from the irregular variations, and ascertain the changes that occur from one season to another, &c., the means of the magnetometer readings at each observation hour, for periods of a month, three months, half a year, or a year, are calculated and published in a tabular form: and their variations are also graphically represented by curves, the abscissas standing for the observation hours, and the ordinates for the magnetometer readings.

Such are the materials from which I have for the most part derived the specific data, and general facts and laws used in the present discussion. In my first investigations on the present subject, commenced several years since, I undertook to determine how far the diurnal variations of declination, &c., might be *represented* by changes of temperature, directly and indirectly. In a paper read before the last meeting of the American Association for the Advancement of Science (held in Washington in April, 1854,) I stated that I had satisfied myself, by an examination of the Toronto observations, that no direct connection could be traced as subsisting between the disturbances of the magnetic needle, whether regular or irregular, and meteorological changes of any kind, occurring at the place; and that accordingly if the principle of terrestrial magnetism exhibits grand features of correspondence to that of terrestrial heat, in its normal aspect, and its more prominent variations, on a nearer view dissimilarities stand revealed, which indicate that another direction must be taken if we wish to gain an insight into the real physical cause of magnetic disturbance. Granting that the perturbations of the earth's magnetic force occur without any reference to meteorological changes that happen at the earth's surface, or in the lower atmosphere, we are led to conclude that the seat of magnetic disturbance is located either in the upper regions of the atmosphere, or is coëxtensive with the magnetic matter that pervades the atmosphere and is distributed through the crust of the earth. Taking up the former idea, I advanced certain reasons for supposing that the sun could only act by some emanation, and undertook to follow out the consequences of a supposed emission of some form of magnetic matter from the sun, and the flow in every direction over the surface of the atmosphere of the streams of this matter that would descend upon the equatorial regions. In the present memoir I have adopted the idea that currents of electricity are excited in the upper atmosphere, *by the sun's action*, and flow in every direction along its surface; also that currents are developed by the sun which flow in a direction parallel to his equator, or nearly parallel to the ecliptic, and from East to West. The conception I have formed of the nature of this action is that it consists in the propagation by ethereal waves of a vibratory motion, or rather an impulse, from the sun to the upper atmosphere. But it should be observed that the question of the truth of this physical conception is entirely distinct from that of the satisfactory explanation of the magnetic perturbations, by the fundamental idea of electric currents just stated. This elevated region, surrounding the earth, whether it be entirely comprehended within the atmosphere, or be more or less exterior to it, I shall call the *Photosphere* of the earth; under the idea that the luminous phenomena, the Aurora Borealis and Aurora Australis, probably occur in this region. At times, I may designate it as the *upper atmosphere.*

Before entering upon a particular examination of the diurnal variations of the magnetic elements that occur at any one place, it will be well to consider how far the laws of these variations are the same in different parts of the earth. The following are the principal results which have been obtained on this point:

1. The laws of the diurnal variations are essentially the same at all places to the north of the Torrid Zone; they are also the same at all places to the south of the Torrid Zone. The only difference noticed is in the amount of the variations, and in the precise hours of the maxima and minima.

2. The laws are the same in the Southern Hemisphere without the Torrid Zone, as in the Northern, if we observe that in the Southern Hemisphere the south end of the needle answers to the north end in the Northern Hemisphere. Accordingly, at the same local hours the north end of the needle is moving in opposite directions at stations in the two hemispheres, without the tropics.

3. At stations situated between the Tropics, the laws of the diurnal movement are not the same throughout the year, as they are very nearly in other parts of the earth; at certain local hours the needle moves in the one direction or the other according as the sun is north or south of the equator.

I may here state that the theoretical views advanced in the progress of the present discussion all have their foundation in one fundamental physical idea with regard to the nature of the electric excitement induced by the sun, and the sun's mode of action. But the physical aspect of the question must, of necessity, be held in abeyance for the present. Let the present inquiry be simply, whether there is any conceivable system of electric currents, which will explain all the diversified laws of the diurnal and annual variations of the declination of the needle, at all the different points of observation, and which will equally well explain the laws of all the variations of the horizontal and vertical forces. If so, it can hardly be doubted that the hypothesis is either a veritable reality, or has its counterpart or equivalent in nature. If it stands the test of quantitative determinations, the conviction of its truth will be strengthened.

It may be well to meet at the outset an objection that may occur to some of my readers. It is implied in what follows (although not perhaps of necessity) that the atmosphere derives its principal electric excitement from a solar action upon its upper regions; when it has generally been supposed hitherto that atmospheric electricity has its origin in the evaporation going on at the earth's surface. But in fact, the old theory of the origin of atmospheric electricity has no longer any basis to rest upon. According to Becquerel, and other able experimenters, electricity is not generated by evaporation unless salts are present in the water. "Some years since M. Riess and M. Reich showed that the electricity attending evaporation proceeded from the friction of the water against the sides of the vase. This fact is proved anew by the researches just published of M. Gaugain, although the results differ in the details from those of the German physicists." If the fact be admitted that the atmosphere is electrically excited by some action of the sun, our views of certain meteorological phenomena must be modified, and we may derive new light with regard to some of these phenomena hitherto enveloped in mystery.

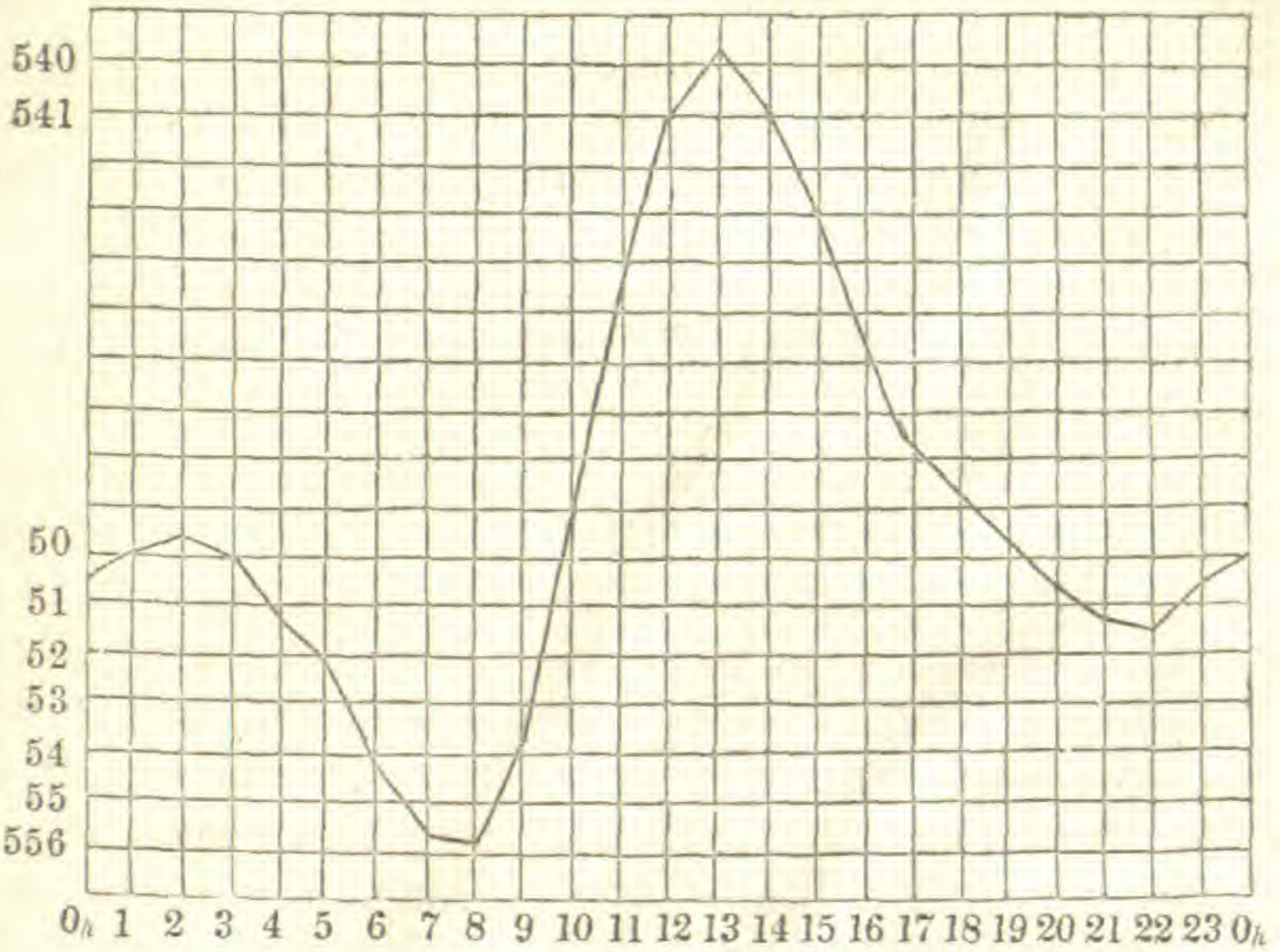
It should be observed that the idea of the magnetic needle, at the earth's surface, being disturbed by electric currents circulating in the upper regions of the atmosphere cannot be regarded as an hypothesis, since we know from observation that the needle is disturbed by the Aurora Borealis, and that this phenomenon is unquestionably attended with the circulation of electric currents in the upper atmosphere. In fact the aurora, with its attendant electric excitement, and electric currents, is the only known terrestrial cause of magnetic disturbance.

DECLINATION.

It is to be recollected that the declination at any particular place may be either East or West; and that in the Southern Hemisphere, as well as in the Northern, it is defined by the position of the North end of the needle with respect to the North point of the horizon.

Diurnal Variations.

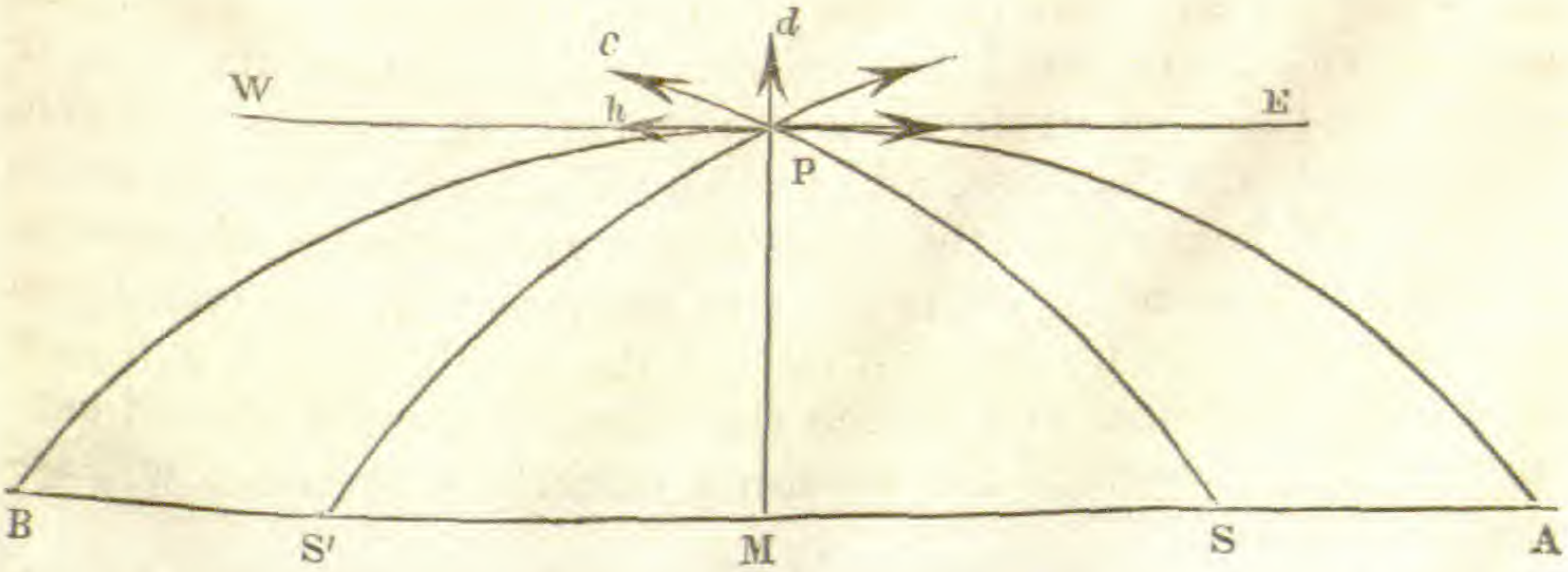
The laws of the diurnal variations of declination are graphically represented in the annexed diagram, (Fig. 1.) On examining it it will be seen that the needle has its minimum of declination, or in other words, that its north end has its most easterly position at 8 A. M. At this hour it begins to move toward the west, and continues to do so until 1 P. M., when it has attained to its maximum of westerly deviation. It now begins to return toward the east, or its declination decreases, and this movement continues until 10 P. M. when there is a second minimum of declination. From 10 P. M. to 2 A. M., there is a small westerly movement again, 1.—*Curve showing the Mean Diurnal Variations of the Declination at Philadelphia, for the year* 1844.



Increase of numbers at the side corresponds to decrease of declination : 0h *answers to midnight.*

and from 2 A. M. to 8 A. M. a greater easterly movement. Thus the declination has two maxima, viz., at 1 P. M., and at 2 A. M., and two minima, at 8 A. M. and 10 P. M. The principal maximum is at 1 P. M., and the principal minimum at 8 A. M. The principal disturbance occurs during the day, and consists in an increase of declination or a westerly movement, from 8 A. M. to 1 P. M., and a decrease of declination, or an easterly movement, from 1 to 10 P. M. The disturbance at night, is of the same nature, but much less in amount ; that is, the north end of the needle first moves toward the West and afterward toward the East.

2.



Now let P (Fig. 2) be the point of the upper atmosphere directly over the station of the needle, EW and PM the parallel of latitude and meridian traced through this point, S the point of the photosphere directly underneath the sun, at a certain hour in the forenoon, AB the parallel of latitude followed by the sun in its diurnal motion, and SP the arc of a great circle followed by the electric current flowing from S to P. Let this current be decomposed into the two equivalent currents P*d* and P*h*, the one lying in the meridian MP, and the other in the parallel of latitude EW. The variations of the current P*d*, as the point S moves westward along the parallel AB, serve to explain the principal westerly and easterly movement of the needle, while those of the current P*h* serve to explain the variations of the horizontal force during the same hours To understand the effect of a current in its action on a magnetic needle, we have only to recall to mind Ampère's rule, viz., to suppose ourselves lying along the current circulating from the head toward the feet, and facing the needle, then the north end will move toward the right; or we may, in the present case, suppose ourselves to be standing, (in a vertical position,) on the line of the current, and to be looking toward the needle from the side from which the current flows, then the *circular* action of the current on the north end of the needle will be in the direction of the motion of the hands of a watch. It follows that when the meridional current in the upper atmosphere is directed toward the North, the needle will be impelled toward the West, and when it is directed toward the South, it will be impelled toward the East. It is manifest that the meridional current P*d* will increase until the hour of noon, and after that decrease, and hence that there should be a westerly movement during the forenoon, and an easterly during the afternoon. The explanation of the fact that the turning point falls an hour or two after mid-day will hereafter present itself. If we suppose APB to represent the azimuth circle which crosses the meridian at P under an angle of 90° (corresponding on the photosphere to the prime vertical in the heavens) early in the morning when the sun is to the east of A, the component meridional current will be directed toward the south; but as the sun, or rather the point of excitement underneath it, moves westward this current will decrease, and vanish altogether when the sun is over A, and hence from the cause under consideration the motion should be westward. After the sun has passed B, the meridional current will again be directed toward the south, but it will now be on the increase, and hence the easterly motion should continue. The reason of the morning easterly movement will appear in the sequel.

The similar nocturnal movements of the needle may be explained in a similar manner, if we suppose that there is another point of excitement on the photosphere from which electric currents flow in all directions, diametrically opposite to the point directly under the sun. If the electric excitement of the upper atmosphere by the sun be indeed a consequence of the propagation of a vibratory motion (or impulse) by ethereal waves, then I conceive that the concentration of the separate currents (individual pulses) at the point diametrically opposite the sun would give rise to a certain increase of excitement, and to currents of a certain intensity flowing in every direction outward from this point along the surface of the atmosphere. The resistance experienced by the individual currents flowing from the point under the sun, together with the diminution from the very law of propagation, should cause the intensity of the electric excitement at this second point to be less than at the first; and accordingly the needle should be less effected at night by the passage of this point along the upper atmosphere than during the day by the passage of the point directly underneath the sun. If the entire mass of the earth should be partially transparent to the wave or force propagated from the sun, then a certain degree of excitement would be produced, at the point diametrically opposite to the sun, by the sun's direct action.

I infer from certain theoretical considerations, on physical grounds, that the radial current proceeding from the two points of maximum electric excitement should be attended with transverse impulses (or circular currents) of a feebler intensity. Such transverse currents, if they be directed from right to left (east to west side), would tend to deflect the needle to the east early in the morning, also to prolong the westerly movement after midday, and to diminish the motion toward the east in the afternoon. Their effects would therefore correspond with phenomena which really occur, and they seem to supply what is wanting in the radial currents to complete the explanation of the diurnal movement. Still there is another set of currents, to which allusion has been made (p. 186), viz. the ecliptic currents, which, as we shall see, generally tend to produce similar effects; and as the fact of the existence and very decided action of these currents can be conclusively established, we must conclude that if the supposed transverse currents really exist, they only conspire in general with the ecliptic currents to produce similar effects, in disturbing the declination. I shall therefore not undertake the explanation in detail of the action of the transverse currents, but content myself with simply pointing out, in each instance, the nature of this action.

I have hitherto regarded the point of the photosphere directly under the sun, as the only point electrically excited by the sun's action, and from which the currents flow; but on theoretical grounds other points upon which the solar emanations fall should be excited in a similar manner and send off radial, and possibly feebler transverse currents. There is however, one possible conception that might be formed of the nature of the sun's action, which confines the radial currents entirely to the great circles diverging from the point underneath the sun. This is that these currents have their origin partly in the polarization of the electric rays by refraction ; the vibration of such a polarized ray would be confined to the plane of incidence and would be attended with two impulses which would be propagated in opposite directions. A longitudinal impulse propagated along the ray proceeding from the sun, by its obliquity to the surface of the atmosphere would give rise to a current flowing away from the sun. But such considerations are foreign to the present inquiry. Taking up now the idea of a general electric excitement of the upper atmosphere which receives the sun's rays, we are to consider the various points of the parallel of latitude followed by the sun, (AB, Fig. 2,) as acquiring more and more electric intensity, (that is more and more intensity of electric vibration,) as the sun approaches them, and as declining in intensity after the sun has passed to the west of them. It is not reasonable to suppose, however, that the diminution of intensity should begin at the moment of the sun's passage through the zenith of the point, for any current excited by the sun's impulse must decline gradually. An hour after this passage, if the sun were to cease to act the moment it reached the zenith, a certain portion of the current then in existence would still be circulating; and hence it follows that the current flowing from the point in question will continue to increase until the diminution of the sun's impulse overbalances the portion of the current that remains undestroyed by the resistances. The current that follows the meridian of the station of the needle (coming from M, Fig. 2,) should then increase until a certain time after noon, and therefore the declination not attain its maximum at the hour of noon. Later in the afternoon the points that lie to the west of the meridian come into most efficient action, and the needle accordingly moves toward the east. Toward sundown the points of maximum electric excitement fall to the west of the prime vertical (PB), and their meridional components are directed toward the south; the easterly motion will therefore continue. During the latter part of the night the points that lie to the east of the prime vertical (PA) acquire a greater intensity of excitation from hour to hour, but as the obliquity of the current that proceeds from the shifting point of maximum excitement, to the prime vertical, increases, the tendency will be to a westerly deflection. This will be diminished by reason of the greater proximity of the points immediately to the east of the prime vertical. In fact, in the summer months, as the sun's action is more in advance on the parallels of latitude to the north, and as the currents from these are nearer and inclined under a larger angle to the prime vertical than those from the parallel under the sun, it may very well happen that the needle will be deflected toward the east. We must take into account the fact that as a line of given excitement draws near the station, the currents from the points of it nearly east of the station will experience a greater proportional increase of intensity than those farther south; because of the law of divergence of the individual currents, and the law of diminution of each individual current from the effect of resistances as the distance traversed increases. Early in the forenoon the determining points fall to the west of the prime vertical (PA), and a decided westward movement should obtain.

I shall show in another connection (see p. 202) that the ecliptic currents play an important part in the forenoon; tending to produce an easterly movement in certain morning hours, (in the summer,) and subsequently a displacement toward the west. The oscillation of the needle first to the east and then to the west, during the forenoon, is a result of the joint action of both systems of currents.

We have hitherto regarded the two component currents which, by their changes of intensity and direction, determine the variations of the declination and horizontal force, as lying, respectively, in the geographical meridian, and in the line crossing the meridian at right angles. Strictly speaking, the primary currents should be decomposed into two currents following the magnetic meridian and traversing this meridian perpendicularly. In this region of the earth the two meridians are inclined to each other under a small angle. For the sake of simplicity I shall continue to consider them as coincident. It will be easy in any special case, to allow for the effect of their actual inclination.

Annual Variations.

Under this head are comprehended all the inequalities of declination, and of diurnal variation of declination, whose period is either an entire year or any fraction of a year. The laws of all such inequalities may be deduced from the following table, taken from Vol. II of the Toronto Observations. (See next page.)

The most conspicuous inequality is that of the diurnal variation. The diurnal range changes materially from one season to another. Thus, in the year 1846, the mean daily range during the months of January, February, November and December was 6′·33; during March, April, September and October 9′·21; and during May, June, July and August 12′·27. The mean for the whole year was 9′·27. It is therefore greatest in the summer, least in the winter, and has an intermediate value in spring and

TABLE I.

Showing the Mean (West) Declination at Toronto at every Observation Hour in every month of the year 1846, *derived from three years of hourly Observations.*

Toronto Time. Astronomical Reckoning.		Jan.	Feb.	March	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
		1° +	1° +	1° +	1° +	1° +	1° +	1° +	1° +	1° +	1° +	1° +	1° +
H.	M.												
12	3	30′·31	30′·63	30′·07	30′·21	30′·25	30′·40	29′·62	30′·23	30′·72	30′·67	30′·08	28′·96
13	3	30·33	30·76	30·17	29·85	31·30	30·94	29·88	30·74	30·03	29·72	31·08	29·23
14	3	29·64	30·65	29·99	30·67	31·48	31·10	30·60	30·75	30·06	29·17	30·95	29·75
15	3	29·74	30·00	30·05	30·07	30·78	31·27	30·88	30·35	29·64	29·60	30·14	29·27
16	3	28·98	30·20	29·94	29·43	30·00	30·36	30·49	30·46	28·75	29·05	30·30	29·38
17	3	29·62	29·28	29·77	28·87	28·26	28·36	28·67	29·09	28·66	28·71	29·91	29·59
18	3	29·43	29·26	29·28	28·13	26·71	25·93	26·02	26·36	29·53	29·37	29·59	30·83
19	3	29·07	28·93	28·63	27·81	25·68	25·13	24·54	24·19	30·20	29·56	29·21	30·14
20	3	28·15	28·42	27·50	27·80	25·71	25·22	24·48	23·97	28·40	28·58	28·21	28·95
21	3	28·33	29·47	27·15	28·35	27·88	26·73	25·98	26·20	29·58	28·71	28·36	28·53
22	3	29·46	30·35	28·97	30·57	31·29	29·38	28·99	30·56	32·34	30·02	29·78	28·89
23	3	31·35	32·18	32·32	33·83	35·08	32·96	32·80	34·25	35·00	32·72	31·87	30·37
0	3	33·19	33·80	34·95	36·49	37·01	35·62	35·58	37·43	38·18	34·82	33·91	31·98
1	3	33·76	34·42	36·51	37·81	37·77	37·32	37·05	38·86	37·83	37·73	37·43	35·59
2	3	33·38	34·10	36·54	37·68	37·22	37·30	37·15	38·31	37·42	35·18	35·02	33·54
3	3	32·76	33·21	35·84	36·91	35·96	36·49	36·43	36·44	35·45	34·02	33·95	32·72
4	3	31·60	32·38	34·49	35·17	34·13	35·12	35·15	34·48	33·33	33·23	33·34	31·99
5	3	30·82	31·98	33·48	33·08	32·50	33·17	33·23	32·70	31·41	32·57	32·52	31·22
6	3	30·48	31·30	32·17	31·93	31·49	31·82	32·05	30·80	30·29	30·67	31·47	30·36
7	3	30·00	30·94	31·32	30·93	31·40	31·11	31·43	30·88	30·73	31·33	29·98	29·57
8	3	28·81	29·93	30·79	30·79	31·47	31·14	31·16	30·56	30·16	30·43	30·12	28·90
9	3	28·92	29·53	29·60	30·03	31·30	30·34	31·08	28·30	30·40	29·61	28·57	28·77
10	3	29·57	29·97	29·98	30·77	30·59	30·31	29·52	29·52	29·70	29·70	29·08	28·31
11	3	29·56	30·16	29·14	29·88	29·98	30·21	29·41	29·51	30·62	30·21	29·42	28·54
Means.		30·30	30·91	31·19	31·54	31·47	31·16	30·92	31·04	31·60	31·06	31·01	30·22

The corrections have been applied for the secular change, reducing to the mean epoch, July 1*st*, 1846.

autumn. The peculiarities of the mean diurnal variation in the opposite seasons of summer and winter, are exhibited in the following curves. (Figs. 3 and 4.)

Besides the difference in the amount of the daily range it may be noted that the diminution of declination in the morning hours is much greater in summer than in winter, and is comprised within a shorter interval of time; also that the turning point, from the easterly to the westerly motion occurs earlier in summer than in winter. The greater diurnal range in summer is a consequence of the *relative* depression of the morning minimum, and elevation of the afternoon maximum. (See also Table I.) The depression is greater than the elevation. The morning minimum is 3′·40 lower in June than in December, while the afternoon maximum is 1′·74 higher in June than in December. At the hour of noon the declination is 3′·64 greater in June than in December.

It will readily be seen that the needle ought to decline farther to the east in the morning hours in summer than in winter, when we reflect that the points of maximum excitation at these hours

Diurnal Variation of the Declination, Toronto.

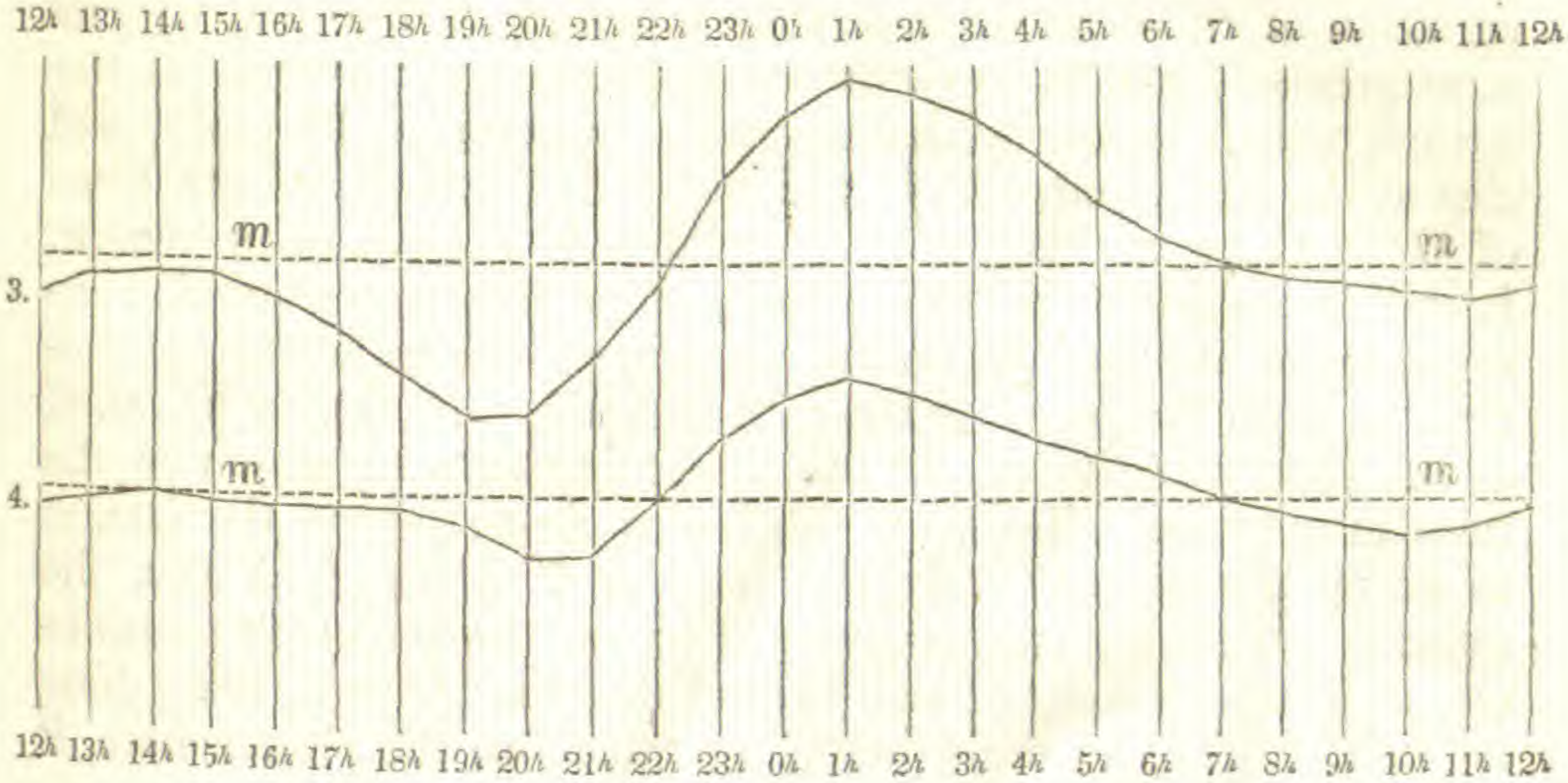
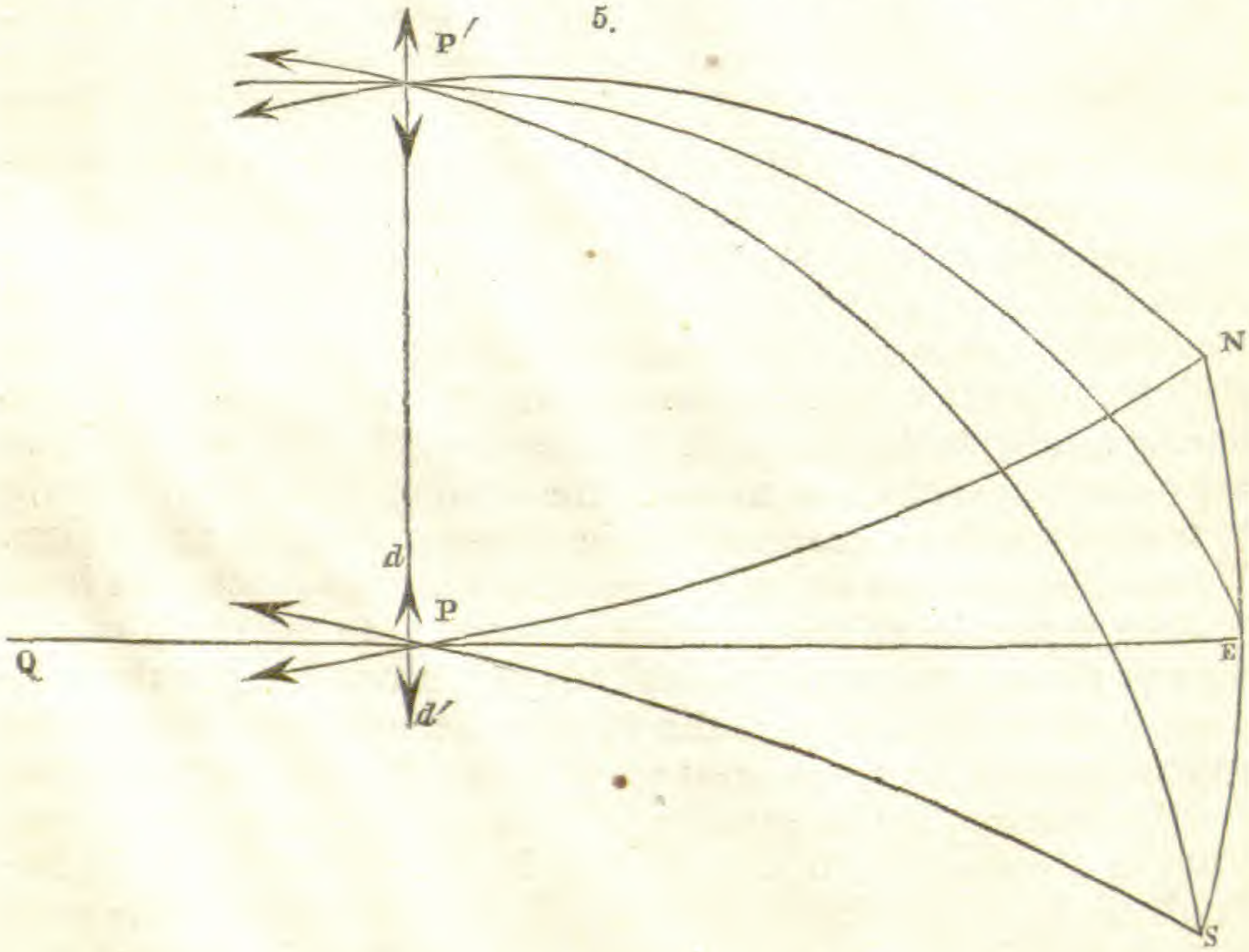


Fig. 3. *April to August, inclusive.*——Fig. 4. *October to February, inclusive. 0h answers to noon. Scale* 0in·25 *to* 1′ *of arc. Ascending curve is increasing declination (West), descending curve decreasing declination: m m, line of Mean Declination.*

lie to the east of the prime vertical and to the north of the equator in summer, and to the west of the prime vertical and south of the equator in winter. On the other hand about the hour of noon, when the points in question are in the vicinity of the meridian, the west declination ought to be greater in summer than in winter. We shall see that the ecliptic currents conspire with the radial in producing a relative depression in the morning. In like manner each system of currents tends to make the turning point, from easterly to westerly motion, occur earlier in summer than in the winter. To consider now the action of the radial currents alone; we have to observe that on all the parallels of latitude to the north of the equator the sun has a greater altitude at a given hour in the forenoon, in the summer than in the winter: hence the points in those parallels, which lie to the west of the prime vertical, have a higher electric intensity in the summer. Thus, at Toronto, the turning point in December is 9 A. M., in June 7 A. M.; now 9 A. M. in December is 1½ hours after sunrise, and in June 4½ hours. The sun's altitude also increases more rapidly in June than in December.

There is another annual variation, which has recently been brought to light by Colonel Sabine. It consists in this: If a comparison is made of the values of the declination at the hour of 7 to 8 A. M. among themselves, it appears that "at the northern solstice the north end of the magnet is at the eastern extreme of a periodical movement, which apart from, and independently of, all other movements whatsoever, has its opposite or western extreme at the period of the southern solstice, and returns into itself at the next return of the northern solstice. It is therefore strictly an *Annual Variation*, or a variation whose period is a year. Its amount is, at Toronto, about five minutes of declination." What is remarkable, we are also assured that an annual variation of the declination at the same hour of 7 to 8 A. M., "almost precisely similar in character and amount," obtains at Hobarton, which is nearly diametrically opposite to Toronto, and also at the two intertropical stations of St. Helena and the Cape of Good Hope, and is probably therefore a general phenomenon. It will be seen upon a little examination that it is a simple consequence of the shifting of the position of the radial current proceeding from the point underneath the sun, which may be taken as the representative of all the radial currents in action at the hour in question. To show this let us first suppose the station to be on the equator. At the hour of 7 to 8 o'clock A. M. the point of maximum excitement will be on the 6 o'clock hour circle, as it lags an hour or two behind the sun. (See p. 192.) Now let EQ, Fig. 5, be the equator, as traced on the photosphere, P

5.



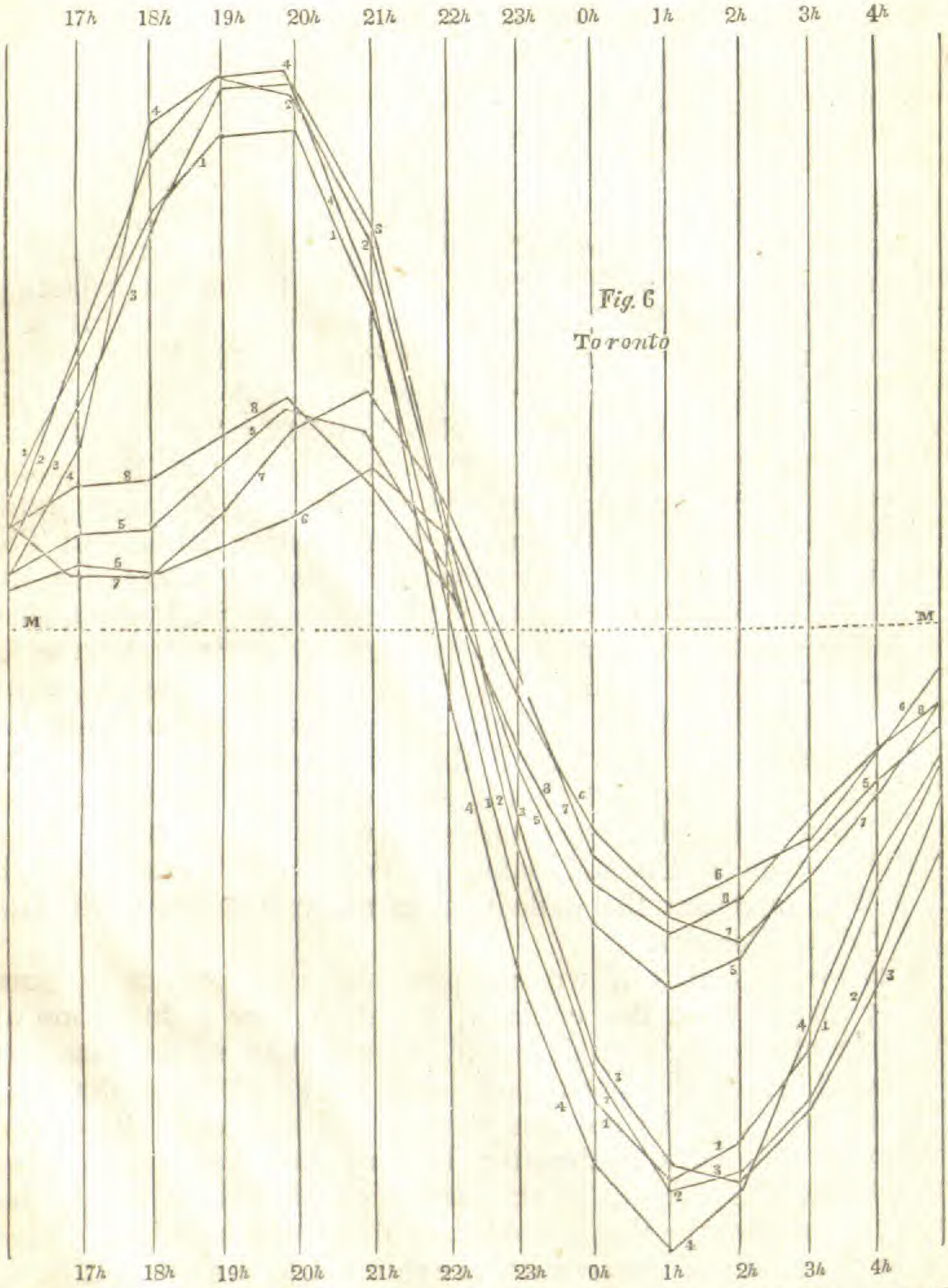
the zenith of the station of the needle, N the position of the point of highest intensity at the time of the northern solstice, on the 6 o'clock hour circle, and S the same point at the time of the southern solstice. NPE=EPS=$23\frac{1}{2}°$. The meridional component of the current along NP will be directed toward the south, that of the current SP toward the north. The former will displace the north end of the needle toward the east, the latter toward the west by an equal amount. (A transverse current, in the present instance, could have no effect, since it would be equally inclined to the meridian at the two solstices, and solicit the needle with the same force toward the east.)

Next suppose Toronto (N. lat. $43\frac{1}{2}^\circ$) to be the station of the needle, and represent it by P′ in Fig. 5. P′E will be the prime vertical on the photosphere; and $P'EQ = 43\frac{1}{2}^\circ$, $P'E = 90^\circ$, and $NE = SE = 23\frac{1}{2}^\circ$. From which we have, $NP' = 74^\circ\ 5'$, $NP'E = 17^\circ\ 30'$, $SP'E = 17^\circ\ 30'$, $SP' = 105^\circ\ 55'$. Current NP′ impels the north end of the needle toward the East, and SP′ toward the West. The meridional component of current $NP' = NP' \sin NP'E$; that of $SP' = SP' \sin SP'E$; hence the deflecting force at Toronto in the interval of the solstices, is to that at a station on the equator in the ratio of $NP' \sin NP'E + SP' \sin SP'E$ to $2\,NP \sin 23\frac{1}{2}^\circ$.* Going through with the calculation we find the ratio to be 0·78. $NP' \sin NP'E = 0{\cdot}312$,† $SP' \sin SP'E = 0{\cdot}312$. The horizontal force at Toronto is to that at the equator nearly as 5 to 9; dividing 0·78 by $\frac{5}{9}$ we obtain 1·40 as the ratio of *deflection* at the two stations, or the deflection being 5′ at Toronto it should be 3′·57 at the equator. I find by calculation, allowing for the west declination of the needle at St. Helena, that the deflection should be very nearly the same at St. Helena as at the equator. At Hobarton it should be about 4′. We may conclude, therefore, that the deflection, so far as it depends on the radial currents, is everywhere in the same direction, from the one solstice to the other, and that it should vary in amount at the four British Colonial Observatories between 5′ and 3′·6. The diagrams given by Colonel Sabine, (Toronto Observations, Vol. II, p. 20,) represent the deflection as about 0′·5 less at St. Helena than at Toronto.

It is obvious that if we compare any two periods of time equally distant from the equinox, we shall have a deflection of the same character, though less in amount than in the case just considered, since the north and south declinations of the sun, (NE and SE, Fig. 5,) are less than at the solstices. Since the change of the sun's declination is very slow before and after the solstice, the amount of the deflection should be nearly the same for the months that precede and follow the solstices. This fact as the result of observation is exhibited to the eye in Fig. 6, (which is a transcript of Fig. 1, p. 20, Vol. II, of Toronto Observations). From the cause now under consideration the same effect should occur at the hours following 7 to 8 A. M.; but it should be less in amount from hour to hour, because the angle NP′S is less and less as the arc NS is carried farther to the west by the diurnal revolution. This fact is also shown in the dia-

* By the arcs NP′, SP′, NP, is meant the force of the currents proceeding from N and S to P and P′.

† Current along $NP' = \frac{1}{\sin NP'}$. The effect of the currents proceeding from any point, as N, varies with the distance by reason of the divergence of the individual currents, which follow arcs of great circles, because of the effect of resistances upon the individual currents, and doubtless also from the very nature of the propagation. The intensity of a galvanic current varies inversely as the square root of the length of the wire traversed.



These curves show the deviations of the declination, at the specified hours, in the months named, from the mean declination in all the months and at all the hours, represented by the horizontal line MM. *An ordinate lying above* MM *shows that the declination (West) at that hour is less than the mean, one lying below that it is greater than the mean.* 1, *May*; 2, *June*; 3, *July*; 4, *August*; 5, *November*; 6, *December*; 7, *January*; 8, *February*. *Scale* 0in·5 *to* 1′ *of arc.*

gram, (Fig. 6). It should disappear at noon, and recur in the afternoon, but we shall soon see that antagonistic causes come into operation in the afternoon, which prevent the same result from being realized. We shall see also that the deflection at 7 to 8 A. M., and the forenoon hours generally, in passing from the summer to the winter months, is not wholly due to the shifting of the radial current from the north to the south side of the prime vertical, as we have thus far considered it.

We must now direct attention to the existence of another form of electric current in the photosphere of the earth, already briefly alluded to, from which several interesting effects ensue. This is a current, or rather system of currents, induced by the sun's magnetic action on the photosphere, and running in a direction parallel or nearly so to the ecliptic and from east to west. I conceive them to be developed by the inductive action (the simple propagation of an impulse probably) of currents traversing the sun's surface in a direction parallel, or nearly parallel to his equator. The physical theory of their excitation does not fall within our present inquiry. The following discussion will, I think, serve completely to establish the fact of their existence. To have a clear conception of their diurnal and annual change of position, we may regard them (or at least those which originate in the lower latitudes) as represented by a single current followiug the direction of the ecliptic traced on the earth, and observe that this is carried around with the sun during the day; and at a given hour of the day goes through in the course of a year the same changes of position that it does during a day. It is also to be observed that the force of this current will be the greatest at or near the point directly underneath the sun. At either equinox, and at the hour of noon, this current will be inclined 23½° to the meridian of the station; at the vernal equinox passing from the north to the south side of the equator, and at the autumnal equinox from the south to the north side. The meridional component of this current will then be directed from north to south at the vernal and from south to north at the autumnal equinox. The north end of the needle ought therefore, to stand farther to the west at the autumnal than at the vernal equinox, at the hour of noon and thereabouts, at all stations. In fact there is an excess at Toronto, at noon, of 3′·23.* (See Table I.) In what precedes I have only considered the action of the ecliptic currents near the equator. In point of fact, the sun acts upon the high as well as the low latitudes, and develops at each point of its action a current which *sets out* in a direction parallel to the ecliptic and follows the course of a great circle. The more northerly currents may in general be approximately represented by a single current passing through the zenith of the station.† Throughout the year,

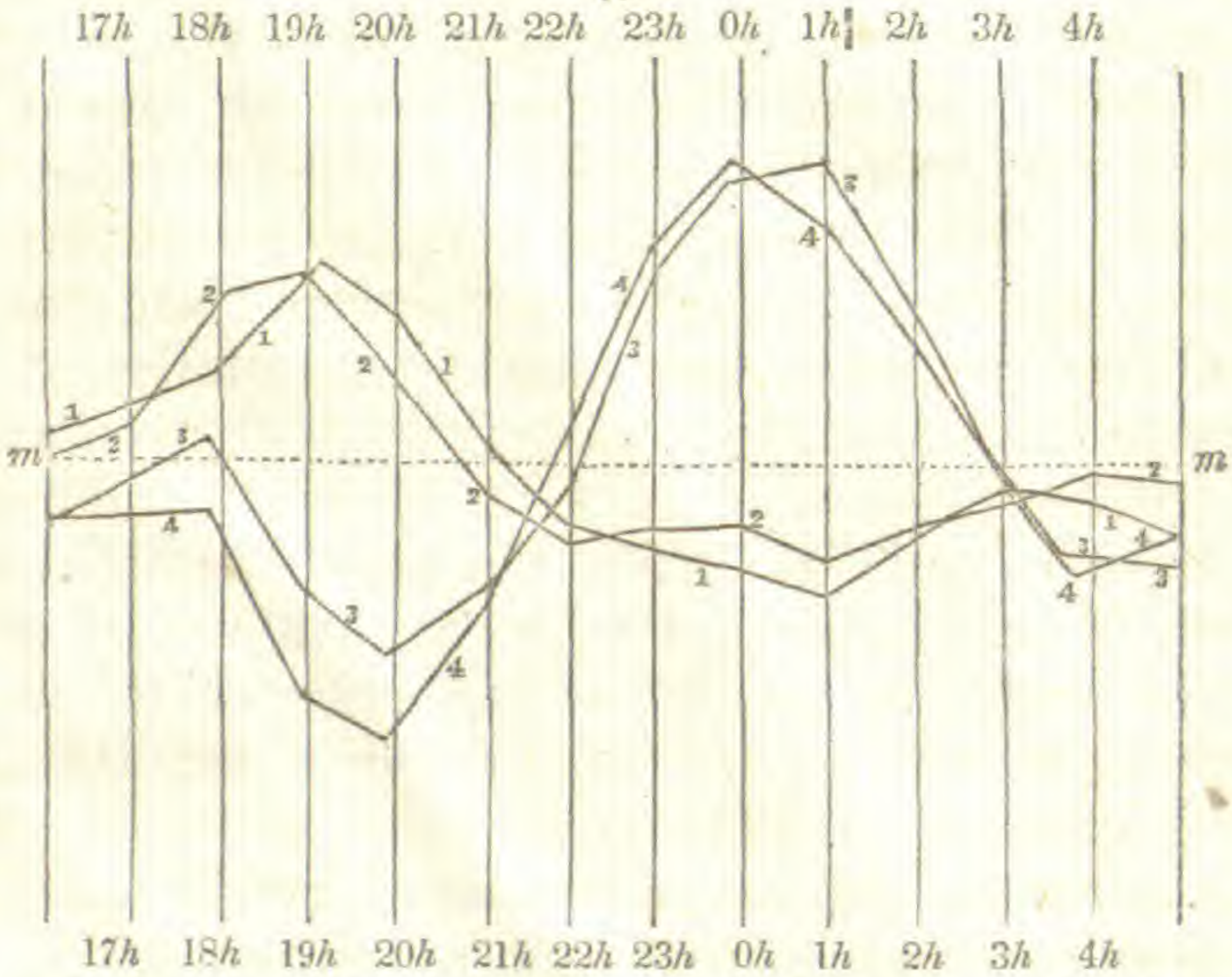
* This inequality of declination, which has its positive maximum at the autumnal and negative maximum at the vernal equinox, and is zero at the solstices, does not appear hitherto to have been noticed.

† More correctly by a single current originating in about the latitude 45°. The station is supposed in the text to be in a high northern or southern latitude (as Toronto). So long as we are only attempting to explain the laws of the phenomena it is not important that we should know the precise starting point of this representative current. It will at any given hour be shifting its position in the same direction, from whatever point in the higher latitudes it be supposed to issue. It is to be observed that, other things being the same, the effect of a current will be the greatest when it passes through the zenith of the station.

the current developed within the Torrid Zone (or rather within a few degrees of the ecliptic) may be represented by a single current following the course of the ecliptic traced on the earth's photosphere. At the equinoxes the northerly currents will cross the meridian at noon, under larger angles than this single ecliptic current, but their tendency will be the same in the inequality just considered. Let us endeavor to obtain a general conception of the entire system of currents now under consideration. *At the solstices* the currents will everywhere, at the outset be parallel to the equator, and the circle traced through the various points from which they proceed at any one instant, will be a meridian and correspond to the solstitial colure. The entire system of currents will pass through the pole of this circle, lying on the equator 90° to the west of the circle. As the earth rotates the circle of excitement with its pole will be carried toward the west, and the inclination of each of these currents to the meridian of any particular station will vary continually. The currents in question will also pass through the other pole, 90° to the east of the circle on which they originate, but they will flow from this pole toward the circle, and from the circle toward the other pole. To the west of the circle they are *leading* currents, to the east of it *following* currents. The two poles will in all cases be diametrically opposite to each other, and on the ecliptic. The starting point of the current that passes through the zenith of the station also varies continually. At 6 A. M. and 6 P. M. this current issues at the pole, at noon its starting point is in the zenith of the station. *At the equinoxes* the circle of excitement will coincide with the circle of latitude (that is circle through the pole of the ecliptic) which passes through the equinoctial points. The currents will set out perpendicularly to this circle and all meet at its pole. This pole will, at the autumnal equinox, lie in the northern Tropic, and move along it toward the west. At the vernal equinox the pole will follow the course of the southern Tropic. During the year it will move along the ecliptic from west to east, keeping always 90° behind the sun. It will therefore pass gradually from one tropic to the other, as the sun does, but be on one of the tropics when the sun is on the equator, and vice-versa. The two poles, or points of concentration of the currents, will always be on opposite sides of the equator, and in the same latitude. At 6 A. M. and 6 P. M., on the day of the autumnal equinox, the current which traverses the zenith of the station originates at a point on its meridian 23½° beyond the pole; at noon at a point a few degrees to the south and east of the station, and crosses the meridian under an angle of 73°. At the same hours on the day of the vernal equinox, the current in question originates at the point on the meridian 23½° on this side of the pole; at noon a few degrees to the south and west of the station, and deviates 73° from the meridian.

At the Solstices, at the hours of noon and midnight, the ecliptic current will have no effect on the declination, since it will cross the meridian of the station perpendicularly. But at 6 A. M. and thereabouts it will tend to produce a deflection of the needle from East to West, in the interval from the northern to the southern solstice; and this in both hemispheres. For at the northern solstice, it will, at this hour, cross the meridian under an angle of 66½°, and tend from north to south, but at the southern solstice it will cross the meridian under the same angle from south to north. The extratropical currents are at this hour more oblique to the meridian, than the intertropical (just represented by a single ecliptic current); but their representative current will have the same inclination to the meridian at the one solstice as at the other, passing from N. of E. to S. of W. at the northern solstice, and S. of E. to N. of W. at the southern solstice. These currents will therefore conspire with those that originate between the tropics in producing an annual oscillation of the needle, from the one solstice to the other. The observed oscillation of about 5′, at 7 to 8 A. M. (see p. 195), is therefore to be regarded as the sum of the effects of the entire system of radial and ecliptic currents. It is to be observed that each set of currents has traversed an arc of nearly 90° before it comes into operation at this hour. The same effect, though less in amount, should occur at each of the successive forenoon hours. In the afternoon the tendency is everywhere reversed; the ecliptic currents are therefore now antagonistic to the radial (see p. 198), and tend to counteract these currents in their tendency to produce the same species of oscillation as in the morning hours. In this way we may explain the comparatively small oscillation that occurs toward 6 P. M. (a fact which is conspicuously indicated by the curves of Fig. 6.) Toward mid-day, and afterwards, the stronger meridional currents, when the sun is at the nearer solstice, has the effect to make the west declination in both hemispheres, greater at the northern than at the southern solstice. We shall have corresponding results if we compare any two months equally distant from the equinox. At intertropical stations they will also be similar if the comparison is made between any two months, on opposite sides of the equinox, at which the sun is on the same side of the zenith of the place. (This qualification is made only with respect to the mid-day relative positions, which are due chiefly to the radial currents.) The same relative positions of the north end of the needle, at the various hours of the day, should in fact obtain on the comparison of two periods very near the equinox, as, the interval from Sept. 1 to 15 with that from Oct. 1 to 15. This appears in the following curves, constructed from the observations made at St. Helena. No. 2 answers to the former interval, and No. 3 to the latter. The ordinates show the deviations of the declination at the several hours from the means for the year at the same hours. An ordinate lying above *m m* shows that the needle is at that hour to the east of its mean annual position at that hour, and an ordinate lying below *m m* shows that the needle is to the west of its mean position.

7.



1, *Aug.* 16 *to* 31; 2, *Sept.* 1 *to* 15; 3, *Oct.* 1 *to* 15; 4, *Oct.* 16 *to* 31.

The ecliptic currents play an important part in modifying the diurnal variations. Let us first see what should be their effects in the northern hemisphere at the time of the *summer solstice.* If we follow the solstitial colure to the point 23½° beyond the pole, we reach the last point excited; this will move from east to west along the polar circle. I find that about 1⅔ hours before 6 A. M. the current from this point will pass through the zenith of Toronto, crossing the meridian under an angle of 34°. At midnight it will cross the meridian perpendicularly, 23½° south of the pole. Soon after midnight the currents from the various points of the arc connecting the point in question with the pole, cross the meridian under a very large angle and far to the north, and they should have but little effect; but as their angle of inclination to the meridian decreases there will be a tendency to an easterly displacement, which will go on increasing up to the hour of $4^h\ 20^m$ A. M. The points of meridian passage of the currents in question will now, some of them fall to the south of the zenith, until finally at 6 A. M. these currents will all pass through the point of intersection of the meridian and equator; which is now the pole of the solstitial colure. Between $4^h\ 20^m$ and 6 A. M. their obliquity will be increased, their meridional components will be augmented, and the easterly motion should continue. The amount of the movement should be somewhat diminished by the southerly progression of the points of meridian passage of the currents. To consider now the effect of the remaining currents; it suffices to investigate the action of the currents of the northern hemisphere, since those of the southern hemisphere cross the meridian under the same angle, but in such a direction as to afford a meridional component in the opposite direction, and being of less intensity, only tend to diminish the effect produced by the currents of the northern hemisphere, without altering its character. The ecliptic currents of the northern hemisphere, now to be considered, proceed from the various points of the solstitial colure lying between the equator and the pole. Before the hour of 6 A. M. the point of meeting of these currents will lie on the equator and to the east of the meridian of the station. The currents after intersecting at this point pass on and cross the meridian south of the equator. As the point of concentration moves westward the obliquity of the currents to the meridian, at their respective points of passage, will increase, and hence the needle will be deflected still more toward the east. After 6 A. M. the obliquity will diminish, and a tendency to a westward movement will obtain. This will be more or less diminished by the continued augmentation of the strength of the individual currents, as the circle of excitement is brought nearer to the meridian, and also by the movement northward of the points of meridian passage of the currents. The currents first considered (before 6 A. M.) will now cross the meridian farther and farther to the south, and under larger and larger angles, and will therefore unite with the others in creating a westward tendency. This tendency to a westward movement will continue until noon, and during the afternoon until 6 P. M. The actual diurnal variation of the declination, is a combination of these effects and of those already noticed, of the radial currents. The variations, as they have been determined by observation, may be ascertained by turning to Table I, and observing the comparative declinations as given for the month of June. It seems that either a tendency to a diminution of declination, produced by the radial currents, from 6 to 7 A. M., prevails slightly over the tendency to an augmentation resulting from the action of the other set of currents; or else that we must ascribe the fall of declination at this hour to the two causes of diminution just mentioned. On either view it is important to observe that the hourly change of the obliquity of these currents, to the meridian, is at its maximum at the hours of 6 A. M. and 6 P. M. (See p. 209.)

Let us pass to the epoch of the *winter solstice*. The effective currents in the morning hours, are now those of the southern hemisphere, and hence as they cross the meridian from S. of E. to N. of W., instead of from N. of E. to S. of W., the tendency of the needle at the same hours, should be in the opposite direction from that which prevails at the summer solstice: that is the declination should increase previous to 6 A. M., and afterward decrease for a time. (See Table I, December column.) There is now no tendency to a diminution in the early morning hours, from any action of radial currents; we have already seen that the slight effect of these is the reverse at this season. In the course of the forenoon, the ecliptic currents of the northern hemisphere will come into preponderating action; because after 6 A. M. the points of meridian passage of these currents will move north, toward the zenith of the station, while those of the southern currents will decline toward the south. The radial currents of the northern hemisphere will also come into action. From both of these causes combined, the declination begins to augment before the hour of noon.

At the equinoxes the resultant of the entire set of ecliptic currents would be a single current following the course of the ecliptic traced on the photosphere, but for the fact that the currents of the two hemispheres cross the meridian under somewhat different angles, and in different points (except at the hours of 6 A. M. and 6 P. M.). *At the autumnal equinox*, before 6 A. M. the currents of the southern hemisphere cross the meridian to the north of the tropic of Cancer, and after 6 A. M. the same is true of the currents of the northern hemisphere. Previous to 6 A. M. we may represent the whole system of currents by a single one in the ecliptic, and another crossing the northern tropic, at the point of general concentration, in a direction from S. of E. to N. of W. For the sake of distinction we will call the former the *primary* and the latter the *secondary* current. After 6 A. M. the secondary current crosses the tropic in a direction from N. of E. to S. of W. Now at the earlier hours the obliquity of the secondary current to the meridian, continually, but slowly, (p. 209,) increases, and hence the needle has a slight tendency westward. The primary current now crosses the meridian from N. of E. to S. of W., and its obliquity rapidly decreases, and hence an increased tendency westward. Later than 6 A. M. the secondary current, now in the northern hemisphere, experiences a slow diminution of obliquity, while the obliquity of the primary current, which now runs from S. of E. to N. of W., rapidly increases. Both currents therefore conspire as before to urge the needle westward. To this westward tendency in the morning hours is perhaps opposed a slight tendency in the opposite direction from the action of the radial currents. The facts in the case will be seen on glancing at the September column of Table I. The movement is westward after 4 or 5 A. M., except from 7 to 8 A. M. The easterly motion at that hour may perhaps be due to the progression northward of the points of meridian passage of the currents, together with the augmentation of their individual intensities by reason of the westward movement of the circle of excitement. Later in the forenoon the shifting position of the ecliptic currents, both primary and secondary, tends to keep up the increase of declination from hour to hour. At noon the declination, so far as it depends on these currents, should be at its maximum. During the afternoon the primary ecliptic current becomes less and less oblique to the meridian, in a direction, S. of E. to N. of W., and hence the needle tends to shift its position toward the east. The secondary current is opposed to this; but its effect will be weakened in the latter part of the afternoon, by the progression southward of the point of meridian passage of the current. The primary ecliptic and the radial currents, therefore, unitedly impel the needle toward the east, while the secondary current urges it in the opposite direction. The hourly change, so far as it is due to the primary current, will be greatest early in the forenoon, and late in the afternoon, and least at noon; so far as it is due to the secondary current, it will be greatest toward mid-day, and least at 6 A. M. and 6 P. M. From the effect of both currents it should be greatest, a short time after the middle of the forenoon. It should be less at the middle of the afternoon, because the secondary current is now opposed to the radial. Table II. (p. 208) gives the hourly change from 9 to 10 A. M. in September 3′·25, and from 2 to 3 P. M., 1′·82.

At *the vernal equinox* the point of concentration of the ecliptic currents is on the Southern Tropic; the secondary current, previous to 6 A. M. will be much less oblique to the meridian, and after that hour much more oblique than at the Autumnal Equinox. The primary current will now, in the earlier hours, run from S. of E. to N. of W.; its obliquity will diminish from hour to hour, and hence there will be a tendency toward the east. After 6 A. M. the current goes from N. of E. to S. of W., and its obliquity increases so that the tendency continues to be the same. In the present case the secondary current is opposed to the primary, but its first effects are slight; for two or three reasons, it is differential in its character, and therefore comparatively feeble, is remote from the zenith, and its hourly change of position is the least possible in the morning hours. On turning to Table I, and examining the column for March, it will be seen that the declination steadily decreases from 3 A. M. to 9 A. M. After this hour the radial and secondary prevail over the primary current, and the deflection is toward the west. In the afternoon the action of the primary current is reversed, while that of the secondary remains the same. We have therefore the primary and secondary ecliptic currents both acting in opposition to the radial and checking the movement toward the East. The amount of the displacement of the needle should therefore be greater in the forenoon than in the afternoon. The actual deflection from 6 A. M. to noon is 5′·67 (Table I), and from noon to 6 P. M. is 2′·78. At the autumnal equinox the three currents act together in the forenoon; and the deflection is 8′·65. In the afternoon the secondary current is opposed to the other two, but its principal effects both in the morning and afternoon lie within three or four hours of noon, because it is then that its position changes most rapidly, (p. 209). At the same hours the primary current is in its position of minimum action. Table I. gives for the deflection in September between 8 A. M. and 12 M. 9′·78, and between 12 M. and 4 P. M. 4′·85.

At other periods of the year the general character of the effects of the currents may be readily ascertained if we reflect that in the summer months, the currents of the Northern Hemisphere prevail throughout the day, while in the winter months the currents of the Southern Hemisphere come into prevailing action in the morning hours, from 4 or 5 A. M. to 8 or 9 A. M.; and that toward the equinoxes the effect of the primary ecliptic current is greater than at other seasons. We see therefore that the curves for the summer months should resemble that for the day of the summer solstice, and the curves for the winter months that for the day of the winter solstice; and that the curves for March and September should be somewhat different. (See Fig. 6, also Hobarton Observations, Vol. I, p. 34.) The change from a westward to an eastward tendency at the hour of 6 A. M. in the winter months, is observable in the curves 5, 6, 7, 8, of Fig. 6. Previous to 5 A. M. there is a slight eastward tendency, except in the curve for January. This I ascribe to the easterly deflection that follows the meridian passage of the point of maximum electric excitement diametrically opposite the sun. This point should be particularly effective in the winter, because its declination is north. The opposite change of tendency, viz., from east to west, at 6 A. M. is to be seen in the curves 1, 2, 3, 4. That the westerly motion does not actually begin at that hour I suppose to be owing to the action of the radial currents, which tend to urge the needle toward the east early in the forenoon. The greater part of the movement in this direction previous to 6 A. M., is doubtless attributable to the same action of the radial currents.

If we compare any one curve with the others, we find that the differences and correspondences which subsist, are in almost every instance such as the theory calls for. Thus, at 6 A. M. the needle should stand farther to the east in June than in May or July, because the ecliptic currents are more oblique to the meridian; also the position should be nearly the same at that hour, in May and July, since the obliquity of the currents is nearly the same. The more easterly position of the needle, at 6 A. M., in August than in June would seem to be an exception, but it is to be observed that the points of meridian passage of the ecliptic currents, at the hour in question, are almost twice as near the zenith of the station (Toronto) in August as in June, and it is possible that this may over-balance the diminution of the obliquity of the currents. Again, from the predominance of the currents of the Southern Hemisphere, there should be an especial tendency to a westward displacement of the needle, at the hour of 6 A. M. in December; but the tendency should be approximately the same in November, December and January. In February it should be less, because the preponderance of the currents of the Southern Hemisphere is diminished, and the primary ecliptic current is less oblique to the meridian. If we pass to the hour of noon, the declination is greater in August than in June because of the greater obliquity of the ecliptic to the meridian; —the increase of this obliquity prevailing over the diminution of the action of the radial currents. In the winter months the mid-day declination should be the least in December, because the tendency of the radial currents to deflect the needle toward the west is then at its minimum. In November the declination at noon should be greater than in January or February, because the ecliptic crosses the meridian in November in a direction from S. of E. to N. of W., and in January and February from N. of E. to S. of W.

It is a consequence of our theory of the combined action of radial and ecliptic currents, that in the middle of the day the declination should be greater at the autumnal than at the vernal equinox. This fact has already been noticed (p. 199). It follows also that the declination should be nearly the same both at 6 A. M. and 6 P. M. at the equinoxes. The actual difference at 6 A. M. is only 0′·25; at 6 P. M. the declination is 1′·9 greater at the vernal than at the autumnal equinox. This excess of 1′·9 is probably in part due to the irregular disturbances, so called, for these are much greater at the autumnal than at the vernal equinox, and at 6 P. M. and for several hours after the easterly disturbance preponderates over the westerly. It also may be in part attributable to the more northerly position, in the latter part of the afternoon, of the point of meridian passage of the secondary ecliptic current. Another consequence of our theory is that the increase of declination from 6 A. M. to noon should be greater at the autumnal than at the vernal equinox; because at the former the three currents are combined in their action, whereas at the latter the primary current is opposed to the other two. The actual numbers are 8′·65 and 5′·67. Let $x=$ rad. + sec. currents (or rather their effect), and $y=$ primary current; then $x+y=8'{\cdot}65$, $x-y=5'{\cdot}67$, $x=7'{\cdot}16$, $y=1'{\cdot}49$. We have an opportunity of verifying this determination of the effect of the primary current. The difference between the declination at noon at the equinoxes must be very nearly equal to twice the effect of the primary current at noon. The amount of this difference is 3′·23, and the half of it is 1′·61 which differs from 1′·49 by 0′·12. The afternoon movement ought also to be greater at the autumnal than at the vernal equinox, for at the former the radial and primary currents are opposed to the secondary, while at the latter the radial is opposed to the secondary and primary currents. The numbers which observation gives are 7′·89 and 2′·78. $7'{\cdot}89-1'{\cdot}49=6'{\cdot}40=$ rad. − sec.; $2'{\cdot}78+1'{\cdot}49=4'{\cdot}27=$ rad. − sec. With Table II, we get the results, 4′·63, 4′·38.

If we make a comparison between the hourly variations at the equinoxes, toward the middle of the day, similar differences ought to obtain. We have, therefore, an *inequality of hourly change of declination*, which has its maximum positive value at the autumnal and its maximum negative value at the vernal equinox.

At the summer solstice all the ecliptic currents tend to deflect the needle in the same direction, as they shift their position at a given hour; and in the forenoon they have the same tendency as the radial currents, in the afternoon the opposite tendency. Taking the numbers given for June (Table II.) we have $x+y=12'\cdot34$, $x-y=6'\cdot11$, $x=9'\cdot22$, and $y=3'\cdot12$. x represents the effect of the radial currents and y the effect of the ecliptic currents from 7 A. M. to 1 P. M., and also from 1 P. M. to 7 P. M. If we compare 6 A. M. to 12 M. with 12 M. to 6 P. M. we have $x=7'\cdot02$, $y=2'\cdot94$.

The ecliptic currents will have some effect in modifying the nocturnal variations of declination, but we will not enter upon the study of their more minute effects on the present occasion. The following table contains the mean hourly variations of the declination for certain hours of the day for a period of six years, from 1842 to 1848, which is half a solar period.

TABLE II.

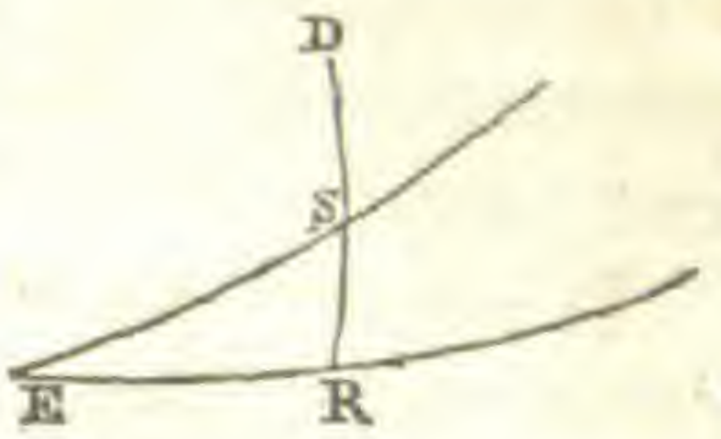
Mean hourly variations of the Declination at Toronto during a period of six years, from July, 1842, to June, 1848, inclusive.

	Jan.	Feb.	Mrch.	April	May.	June	July.	Aug.	Sept	Oct.	Nov.	Dec.
17h. to 18h.	W. 0·06	0·00	E. 0·54	E. 0·94	E. 1·53	E. 2·31	E. 2·01	E. 2·64	E. 1·28	W. 0·29	W. 0·02	W. 0·05
18h. to 19h.	E. 0·56	E. 0·42	E. 0·94	E. 0.44	E. 0·97	E. 1·00	E. 1·47	E. 1·68	E. 1·25	E. 0·51	E. 0·60	E. 0·28
19h. to 20h.	E. 1·04	E. 0·54	E. 1·12	E. 0·15	E. 0·03	W. 0·25	E. 0·19	W. 0·06	W. 0·94	E. 0·98	E. 0·75	E. 0·31
20h. to 21h.	E. 0·42	W. 0·84	W. 0·02	W. 1·00	W. 1·83	W. 1·55	W. 1·70	W. 2·30	W. 1·66	W. 0·18	W. 0·16	E. 0·61
21h. to 22h.	W. 1·11	W. 1·15	W. 2·05	W. 2·18	W. 3·28	W. 2·87	W. 2·85	W. 4·03	W. 3·25	W. 1·68	W. 1·52	W. 0·66
22h. to 23h.	W. 1·76	W. 1·98	W. 2·93	W. 3·05	W. 3·40	W. 3·63	W. 3·38	W. 3·49	W. 2·99	W. 2·67	W. 2·21	W. 1·68
23h. to 0h.	W. 2·16	W. 1·50	W. 2·74	W. 2·48	W. 2·18	W. 2·67	W. 2·74	W. 2·28	W. 1·92	W. 2·00	W. 1·67	W. 1·66
0h. to 1h.	W. 0·87	W. 0·23	W. 1·43	W. 1·23	W. 0·86	W. 1·37	W. 1·42	W. 0·98	E. 0·21	W. 0·43	W. 0·76	W. 0·96
1h. to 2h.	W. 0·06	0·00	W. 0·01	E. 0·06	E. 0·29	E. 0·02	W. 0·12	E. 0·68	E. 0·83	E. 0·24	E. 0·29	W. 0·01
2h. to 3h.	E. 0·59	E. 0·84	E. 0·67	E. 0·86	E. 1·10	E. 0·92	E. 0·84	E. 1·82	E. 1·82	E. 1·06	E. 1·11	E. 0·75
3h. to 4h.	E. 0·91	E. 0·86	E. 1·11	E. 1·66	E. 1·71	E. 1·59	E. 1·29	E. 1·86	E. 1·79	E. 0·94	E. 0·73	E. 0·98
4h. to 5h.	E. 0·84	E. 0·46	E. 1·10	E. 1·53	E. 1·70	E. 1·82	E. 1·83	E. 1·55	E. 1·26	E. 0·77	E. 0·73	E. 0·94
5h. to 6h.	E. 0·61	E. 0·72	E. 1·03	E. 1·05	E. 1·01	E. 1·10	E. 1·20	E. 1·42	E. 0·63	E. 1·19	E. 1·10	E. 0·63
6h. to 7h.	E. 0·58	E. 0·37	E. 0·80	E. 1·00	E. 0·22	E. 0·66	E. 0·56	W. 0·09	E. 0·28	E. 0·07	E. 1·01	E. 0·67

The direction of movement of the north end of the needle is indicated by the letter, E or W, placed over the number.

In what precedes the law of variation of the angle included between the ecliptic and meridian, from one hour to another, or from one season to another at a given hour, has been assumed. I propose now to establish it. Let ER (Fig. 8) represent the equator, ES the ecliptic, and DSR a meridian; put ESR=S, ES=L, SER=ω=23½°. Then

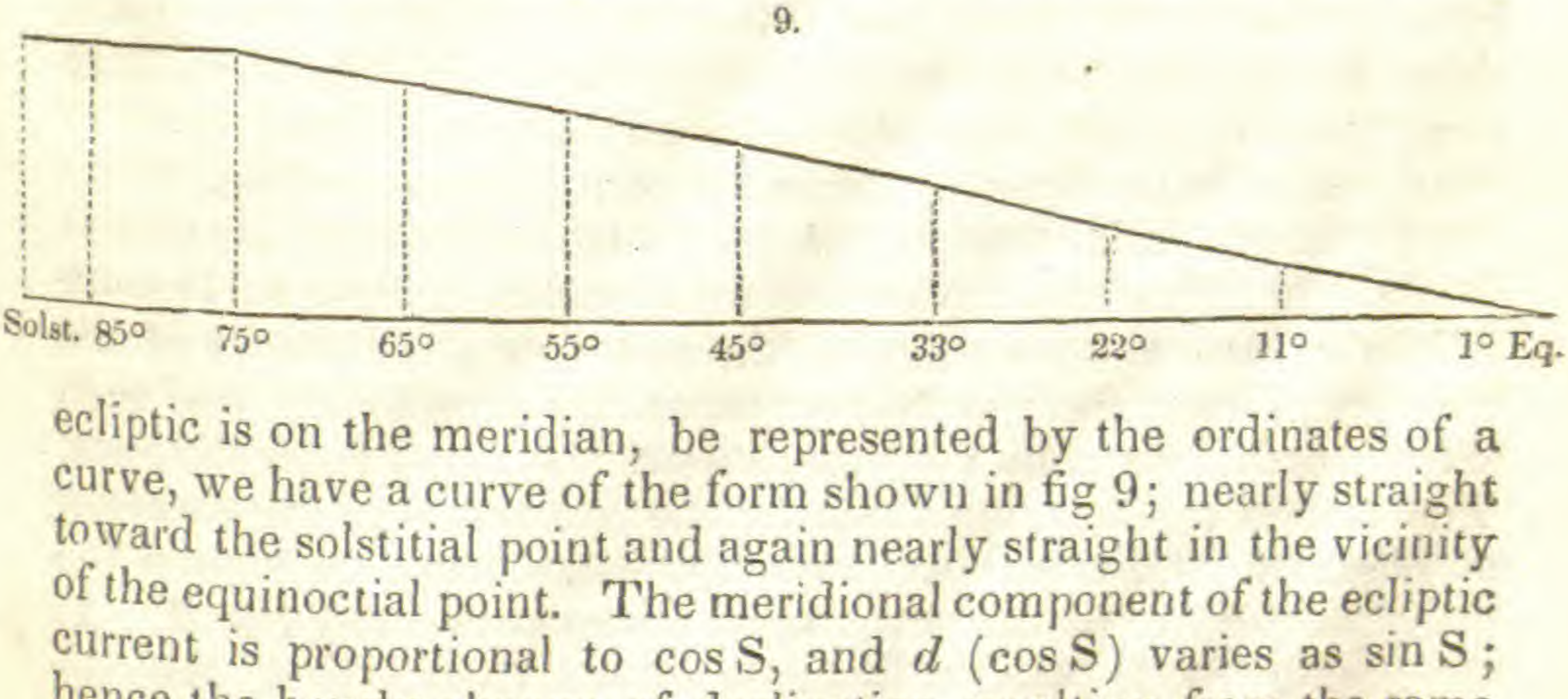
8.



$$\text{tang}\, S = \frac{\cot \omega}{\cos L},\ d\,(\text{tang}\, S) = \cot \omega \frac{\sin L\, dL}{\cos^2 L} = \cot \omega . \frac{\text{tang}\, L}{\cos L} dL.$$

Thus the hourly variation of tang S is proportional to $\frac{\text{tang}\, L}{\cos L}$. For L=1°, 11°, 22°, 33°, 45°, 55°, 65°, 75°, 85°, d(tang S)= ·017, ·197, ·436, ·765, 1·41, 2·50, 5·07, 14·4, 131. The corresponding values of S are, 66½, 66° 53′, 68° 3′, 69° 58′, 72° 55′, 76°, 79° 35′, 83° 35′, 87° 50′. The variations of the angles corresponding to the above variations of the tangent are as the numbers 1, 11, 22, 33, 44, 53, 60, 64, 64. If the hourly variations of the obliquity of the ecliptic current, as one or another part of the

9.



ecliptic is on the meridian, be represented by the ordinates of a curve, we have a curve of the form shown in fig 9; nearly straight toward the solstitial point and again nearly straight in the vicinity of the equinoctial point. The meridional component of the ecliptic current is proportional to cos S, and d (cos S) varies as sin S; hence the hourly change of declination resulting from the same change of the obliquity of the current is greatest at the solstitial and least at the equinoctial points. A curve showing the hourly change of declination that would result from the actual change of position of the current, would then differ from the preceding in being slightly more curved toward the solstitial point. The law of variation would be the same if we take any individual ecliptic current, instead of the primary current (so called) just considered, for this does not depend on the value of the constant, cot ω; it would also be the same for any single current taken as the representative of the ecliptic currents more remote from the equator.

It appears to me that the two laws recently made out by M. Secchi are deducible from the theory of ecliptic currents, taking into acccount the law of variation of their angles of inclination, to the meridian, just established, but as I have only seen a meagre statement of his researches (in the Comptes Rendus) it would be premature to enter into a detailed discussion of them in the present paper.

It remains to discuss the peculiar variations of declination that occur at intertropical stations, which have been signalized by Col. Sabine. In the first volume of the Hobarton Observations we find the following statement; "the diurnal variation between the hours 2 A. M. and 10 A. M. at St. Helena correspond in respect to the direction in which the magnet moves in the months from April to August with the phenomena of the Northern Hemisphere, and from October to February with those of the Southern Hemisphere." Similar phenomena are observed at the Cape of Good Hope. The comparison between the diurnal movements at short intervals before and after the equinox is made in Fig. 7, p. 202; the same opposition of movement in the forenoon is here seen to exist very near the equinox. These curious phenomena may readily be referred to the action of the ecliptic and radial currents. When the sun is north of the equator the currents in the Northern Hemisphere predominate, and when he is south of the equator those in the Southern Hemisphere predominate. Now we have already seen (p. 202) that when the sun is considerably north of the equator the tendency of the action of the currents of the Northern Hemisphere, is to impel the needle eastward previous to 6 or 7 A. M. and afterwards toward the west, and that when he is south of the equator the tendency of the action of the currents of the Southern Hemisphere is the reverse at the same hours; and such are the actual diversities of movement that have been observed. The curves representing them for the months near the solstices, as observed at St. Helena, have the same form, and have the principal turning points at the same hours as those of Fig. 7. As the station (St. Helena) is in the Southern Hemisphere, the currents of the Southern Hemisphere, when they predominate have a more energetic action than those of the Northern Hemisphere, when in most effective action. Toward noon, (when the sun passes to the north of the zenith,) the radial currents *from within the tropics* will increase the tendency toward the east. In case the sun is north of the equator, the radial currents in question and the predominating currents from the high latitudes are opposed to each other, at that hour, but when he is south of the equator they conspire to produce an eastward movement. We see therefore that the deflection toward the west, late in the forenoon, in the former position of the sun should be less than the deflection toward the east in the latter position. In the afternoon the radial currents that come from points within the tropics will again be in opposition to the predominating extratropical currents when the sun is considerably to the north of the equator, and in coincidence of action when the sun gets to the south of the equator. (See Fig. 7.)

Let us take now the special case represented in Fig. 7. The same effects will occur that we have just considered; they will only be less in amount. But we may also discern effects produced by the primary ecliptic current. Before and after the equinox this current crosses the meridian under a large angle, early in the morning, and by the rapid shifting of its position tends to deflect the needle more and more toward the west during the forenoon. During the afternoon the tendency is reversed. It is thus opposed to the intertropical radial current during the greater part of the day both before and after the equinox. At the earlier date, at which the sun is north of the equator, the primary current crosses the meridian early in the morning in a direction from N. of E. to S. of W.; and at the later date it runs at the same hour in a direction from S. of E. to N. of W. The needle ought therefore to have a greater west declination early in the morning after than before the equinox. That such is the fact will be seen on inspecting Fig. 7.

It is to be observed that the easterly movement of the needle from 6 to 7 A. M., when the sun is north of the equator, and westerly movement at the same hour when the sun is south of the equator, is attributed to the action of the radial currents. When the sun has a south declination the westerly tendency resulting from the action of the radial currents, from 6 to 7 or 8 A. M., should be relatively greater at St. Helena than at Toronto. Accordingly the radial may prevail over the ecliptic currents at that hour, at St. Helena, and the ecliptic over the radial at Toronto; (compare Figs. 6 and 7.)

It may be stated in general terms that the peculiar phenomena of the diurnal variation of the declination which have place at St. Helena and the Cape of Good Hope, and probably at intertropical stations generally, receive their explanation in the alternate preponderance of the extratropical currents of the Northern or Southern Hemisphere, according as the sun is north or south of the equator; together with the modifying action of the ecliptic and radial currents that are developed between the tropics.

(*To be continued.*)

Art. XX.—*Observations on the fructification of the Arachis hypogæa;* by Hugh M. Neisler, Columbus, Geo.

In studying our Stylosanthes a few years ago, my attention was attracted by a note in Torrey and Gray's Flora of North America, vol. i, p. 354. viz., "Mr. Bentham in a paper on the affinities of Arachis, read before the Linnæan Society in 1838, gives an account of the two kinds of flowers in Stylosanthes, and shows its affinity to Arachis, which he considers a genuine Hedysarea." I presumed that he supposed the Arachis to have two kinds of flowers, but, wishing to inform myself accurately as to his views, I mentioned the subject to Dr. Torrey in the course of our correspondence, who remarked in reply; "Mr. Bentham says, that Arachis has two kinds of flowers. Those that have all the parts, do not perfect their fruit, the ovary never ripens. The fructiferous flowers, have neither calyx, corolla, nor stamens, but consist at first of a minute ovary on a rigid stipe that arises from between two bracteoles. After fecundation, the minute ovary swells, at the same time burrows in the ground where it ripens.

On examination, I found in some specimens that had been in flower some days, in the axils of two or three of the lower leaves, minute, sessile (sometimes two or three in a kind of one-sided raceme) conical germs situated between two bracteoles; these gradually elongated themselves until reaching the earth, they penetrated beyond the reach of light, where their extremities becoming etiolated they grew succulent, enlarged and ripened their fruit. The stipe of the fruit varies much in length, in the prostrate forms of the plant from 1 to 3 or 4 inches—but in an upright variety which I cultivate, they grow 6, 12, and sometimes, even 18 inches before reaching the earth and in their growth hang around the stem like aerial rootlets. In the axils next above these fertile germs, in my specimens, I found petal-bearing flowers, which I at first (supposing Mr. Bentham's views of course to be correct) regarded as barren. But after close and repeated examinations, to my surprise, I found them in all respects perfect, and what at first sight I had thought a long peduncle which withered with the flower, proved to be a slender, tubular *calyx*, through which there was no difficulty in tracing the style to a minute conical germ, situated between two bracteoles—and in all respects identical with those in the axils below. And after examining a few plants, I succeeded in finding germs elongated to two or three inches with the marcescent calyx and corolla still *adhering to their points*, and stimulated into growth beyond a doubt by the perfect and fertilized ova. Younger plants just getting into bloom showed petal-bearing flowers in the lowest axils and doubtless those that I first examined and which I thought achlamydeous, would have been found so, if seen a little earlier; for generally, the flower falls away entirely and is seldom found attached to the germ after withering. *The flowers of the Arachis hypogæa are all petal-bearing and all fertile.* The plant is in some respects a singular one—and I am not surprised that Mr. Bentham or any one else who had not watched it in all stages of its growth, should have fallen into error as regards its fructification.

ART. XXI.—*On certain Physical Properties of the Light of the Electric Spark, within certain Gases as seen through a Prism;* by D. ALTER, M.D., of Freeport, Pa.

IN a former communication, I noticed the peculiar character of the light produced by interrupting the galvanic circuit, between different kinds of metal. I also mentioned that several bright bands were observed in the common electric spark. I have since employed various metallic conductors, but without producing the bands corresponding with those resulting from the interrupted galvanic circuit between the same metals—the bands always remaining the same, whatever metal was employed. It then occured to me, than the bands were characteristic, not of the metals, but of the atmosphere, through which the sparks passed. To test this view, I passed the spark through various gases, in succession, and found that they were characterised by their appropriate bands, with as much distinctness, as the metals are, by the galvanic spark; e. g., I discovered in atmospheric air, one red, one orange, two green, one blue, and one indigo: while in hydrogen, I discovered one very bright red, two faint green bands, and one very faint blue. In nitrogen, one red, one orange, and two green. In chlorine, two distinct green bands, and a knot of light in the yellow and also in the blue, which I think are composed of several bands close together in each. In carbonic acid, there are, one red, three orange and two green bands. In sulphuretted hydrogen, there are red, orange and green bands. In oxygen, no bands were discovered, but the light was strong throughout the spectrum. In the other gases it is feeble, except in the bands before mentioned. The quantity of light in the red band of the spark, in hydrogen, is quite remarkable, being so great, that the spark, seen without the prism, has a very red appearance, as also in the gases compounded of hydrogen. From this, we perceive the cause of the difference in color, in the flashes of lightning—for when the electricity has a watery conductor, in much of its course, it will emit red light, but when it passes through air, the light will be white: as in the spark through that medium, the bands are well distributed among the colors of the spectrum. The colors also, observed in the aurora borealis, probably indicate the elements involved in that phenomenon. The prism may also detect the elements in shooting stars, or luminous meteors.

Since from the preceding observations, it is evident that the electric light, whether from the interrupted galvanic current, or from the common electric machine, is principally resolved into several bright bands by the prism; and that the light, thus produced by one elementary body, differs in the number, brilliancy and situation of its bands, from every other element, so that it is immediately recognised, by mere inspection—we are led to the following inquiries. Is their such a *fluid* as electricity? or, are the phenomena, commonly reputed electrical, the result (as suggested by Prof. Graham) of chemical affinity? If so, are there only two poles, a chlorous and a zincous, to each molecule—or, are there as many poles or combining surfaces as are indicated by the number of bright bands of its refracted light? And (if the undulatory theory of light may be depended on) would not these bands give an indication of the size of those surfaces or poles?

On Daguerreotyping the dark lines in the Solar Spectrum.—Being desirous to know whether corresponding lines exist in the actinic rays, I adopted the following method. The sun's rays were admitted into a dark chamber, between the edges of two pieces of sheet brass about eight inches in length and separated about the thirtieth of an inch, at one end, but in contact at the other.

Near the outside of the aperture thus formed, was placed a large lens, five feet in focus. Near the focus of the lens in the chamber, the rays pass through a prism and through a second lens of about 20 inch focus, which shows the dark lines very distinctly on white paper, at its focus, for rays coming from the slit. The prepared Daguerreotype plate, placed in the focus and exposed for one or two seconds, produces the effect.

In the Daguerreotype, which I send you there are two spectra caused by filing the brass slips so as to cause an aperture on side of the point of contact. I have placed the letters on the lines as given in Brewster's Optics, 1837, page 79. They would correspond with Prof. Draper's (see this Journal, March, 1848) if the H occupied the place of I.

I could not see the spectrum farther than the breadth of the second broad line at I in the direction beyond that line, when looking through the prism and slit at the sun. But by receiving the spectrum on paper stained with alcoholic tincture of turmeric, several dark lines can be seen beyond these and the blue appears to be changed to violet down to the line F.

ART. XXII.—*Synopsis of the Ichthyological Fauna of the Pacific slope of North America, chiefly from the collections made by the U. S. Expl. Exped. under the command of Capt. C. Wilkes, with recent Additions and Comparisons with Eastern types;* by L. AGASSIZ.

(Continued from p. 99.)

EXOGLOSSUM, *Raf.*

THUS far a single species of this remarkable genus is known, which was first described by Lesueur, under the name of *Cyprinus maxillingua* in the first volume of the Journal of the Academy of Natural Science of Philadelphia, p. 185. Lesueur however already suspected that this species would constitute a separate genus, but until the discovery of another similar species he would content himself with referring it to the genus *Cyprinus.* His expectation of such a discovery has however not been realized, since the three species soon afterwards referred to this type by Rafinesque, who first introduced for it the name of Exoglossum, and those described at a later period by Kirtland and Valenciennes do not in reality belong to it. This is another among the many instances which show that the importance of generic peculiarities does not necessarily depend upon the number of species in which they occur. Rafinesque states that he had thought of calling this genus *Glossognathus*, but that this name appearing to him rather harsh, he has proposed that of *Exoglossum*, for the sake of euphony. Valenciennes remarks that he would have preferred that of Glossognathus, which he had himself introduced for this genus, before he read Rafinesque's paper. As matters now stand, we can have no choice, the name of Exoglossum standing by the right of priority and general acceptance.* DeKay is certainly wrong in referring this fish to the genus Catostomus, with which it has no generic affinity, as I have already shown. In calling the typical species *Exoglossum Lesueurianum*, Rafinesque has paid a deserved tribute to the able French naturalist who discovered this fish; but in so doing, he has acted contrary to the universally acknowledged law of priority, which requires that specific names once established, should never be changed, unless they are absolutely objectionable, which is by no means the case in this instance. I do therefore not hesitate in restoring the specific name of *maxillingua*, first given to this fish by Lesueur, who discovered it in Pipe Creek, Maryland.

Valenciennes describes specimens from Pennsylvania. I have myself obtained numerous specimens from different localities;

* I have introduced this and similar other remarks in my paper, not merely with reference to the subjects under consideration, but chiefly as hints to American Zoologists, who in their writings seem not always to take sufficiently into consideration the traditional rules which have guided Naturalists since the days of Linnæus, in matters of nomenclature.

through the kindness of Professor S. S. Haldeman from the Susquehannah River; from Carlisle, Pennsylvania, through Prof. Baird; from Hollidaysburg, Pennsylvania, where it is called Cuttlips, or Niggerfish, through J. R. Lowrie, Esq.; from the Juniata River, where it is called Daychub and Niggerchub, through Prof. Th. C. Porter, and from Nichols, Tioga County, New York, where it is called Mullet, through R. Howell, Esq., so that its geographical range appears much wider than was known before.

As to the other species referred by Rafinesque to the genus Exoglossum, it may easily be ascertained on comparing his figures and descriptions, that neither of them belong to this tribe and one not even to this family. His *Exoglossum macropterum*, for which he himself afterwards proposed the generic name of *Hypentelium* is only a young Catostomus nigricans; his *Exoglossum annulatum* belongs to my genus *Melanura* of the family of Erythroids or Characini; and his *Exoglossum nigrescens* is only a synonym of his own Exoglossum annulatum with a less marked caudal spot. These nominal species have nevertheless been introduced by Valenciennes into his Histoire Naturelle des Poissons, upon the authority of Rafinesque, and hence reproduced by Dr. Storer in his Synopsis of the Fishes of North America. The Exoglossum dubium of Dr. Kirtland and Valenciennes, Exoglossum spinicephalum truly belong to the tribe of Chondrostoma, but as we shall see below they constitute a distinct genus, differing in some marked structural peculiarities from Exoglossum proper, as well as from the European genera of that tribe.

Thus restricted to its proper limits the genus *Exoglossum* is characterised by the following peculiarities: Body elongated, cylindrical, slightly compressed, covered with medium sized scales. Head flattened above; sides of head vertical; mouth terminal, and yet opening downwards owing to the shortness of the lower jaw, which fits within the upper and is entirely concealed from above by the broad upper lip, when the mouth is closed. The lower jaw has three distinct lobes, the middle one of which is larger, simulating a tongue, owing to the projection of a symphysis of its two branches between the lateral lobes of the lower lip. In fact the lip is wanting in the middle of the lower jaw, or reduced to a thin somewhat cartilaginous covering on the anterior portion of the jaw, whilst on the sides towards the angles of the mouth it remains large and fleshy, producing the appearance of a three-lobed lower jaw. The ventrals are further backwards than in most Cyprinoids, their insertion being nearer that of the anal than that of the pectorals, and their tip when bent back reaching the anal. The scales are almost quadrilateral, with rounded angles and a somewhat projecting posterior margin. Their vertical diameter is scarcely greater than the longitudinal. The centre of radiation is in advance of the centre of outline. The radiating furrows do not converge regularly towards the centre, but occupy near it a broader field than usually and diverge towards the posterior margin in such a manner that the concentric ornamental ridges of the lateral fields and of the anterior field are not intersected by them.

The pharyngeal teeth are arranged in two rows, the outer one with four somewhat compressed teeth, curved inwards, terminating with a small hook and provided with a small grinding surface upon the inner margin. The inner row has only a single tooth, more conical than the outer ones and much smaller. The insertion of these teeth lower upon the branch of the symphysis than usually is also quite characteristic.

10.

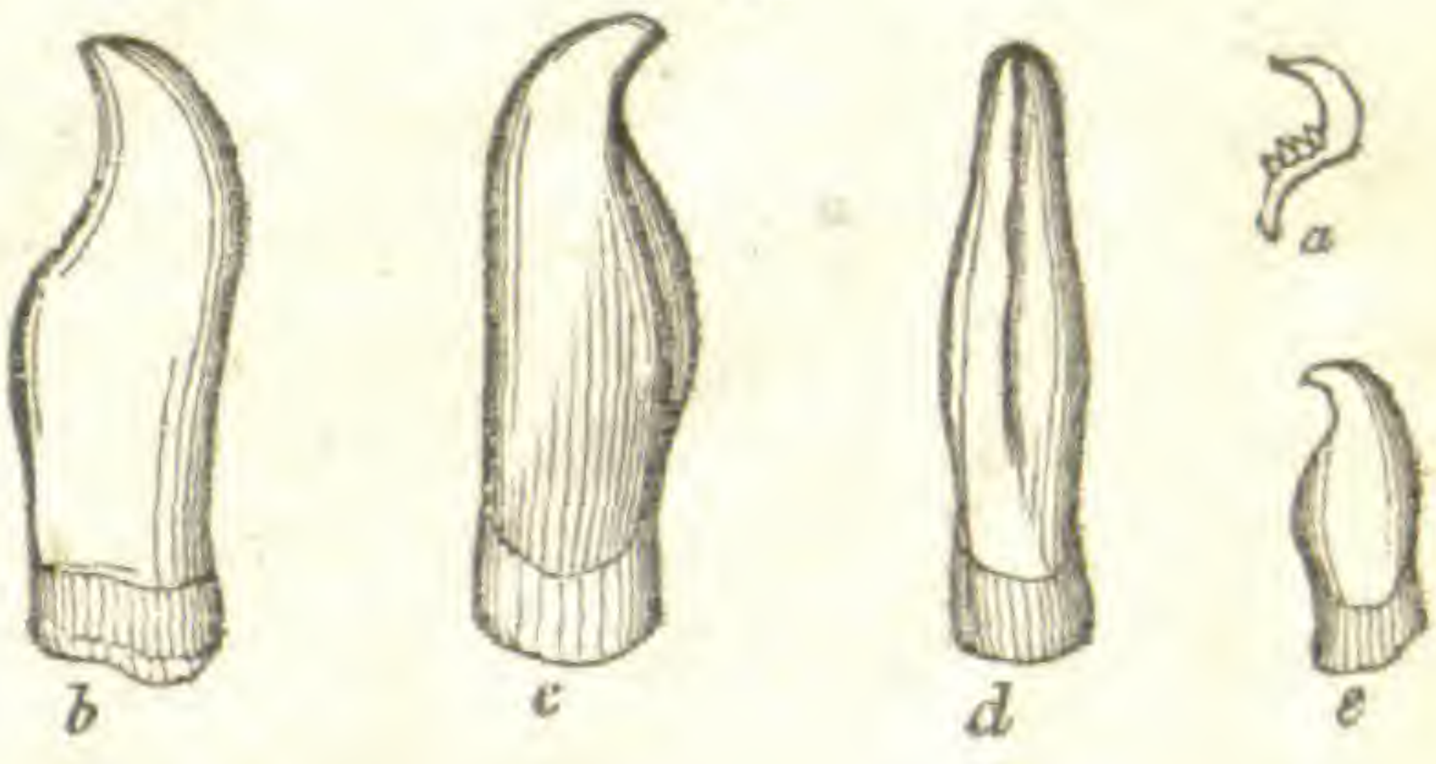


Fig. 10, *a*, represents the right pharyngeal of Exoglossum maxillingua, *b*, *c* and *d*, the longest tooth of the outer row from three sides and *e*, the smallest in profile.

[NOTE ON *Melanura*, Agass.—Few fishes have been referred to so many different groups with which they have no affinity as the type of the genus I have called *Melanura*. First described by Rafinesque in 1820, in the first volume of the Journal of the Academy of Natural Sciences of Philadelphia, under two different names, as ***Exoglossum annulatum*** and ***nigrescens***, it reappears in 1842 as a new species in DeKay's Report, without any reference to Rafinesque, under the name of *Leuciscus pygmæus*.* It is introduced a second time in the same work under the name of *Hydrargyra atricauda*, though Rev. Z. Thompson had already described it anew shortly before the publication of that work, under the name of *Hydrargyra fusca* in his History of Vermont. In 1843, Dr. W. O. Ayres described it for the sixth time as a new species under the name of *Fundulus fuscus* in the 6th volume of the Boston Natural History Journal, p. 296. He however added to our knowledge of its structure by describing correctly the jaws. In 1846 Dr. Storer trusting implicitly to his predecessors, mentions it still under the head of three different genera in his Synopsis of the Fishes of North America, as Leuciscus pygmæus, Fundulus fuscus and Hydrargyra fusca.

All these descriptions relate only to two species of one and the same genus, which however belongs neither to the family of Cyprinoids, nor to that of Cyprinodonts in which the intermaxillaries form the whole margin of the upper jaw, but con-

* I am indebted to Professor Baird for specimens of the Leuciscus pygmæus of DeKay from the same locality as those described in the Natural History of New York, without which I would hardly have suspected even the generic identity of that fish with DeKay's own Hydrargyra atricauda.

stitutes a North American representative of that curious type first described by Gronovius, under the name of Erythrinus, from the Brazils. The genus Erythrinus, divided by J. Muller into two genera: Erythrinus proper and Macrodon, was referred by him to his family of Characini and afterwards raised by Valenciennes to the rank of a distinct family under the name of Erythroids, to which he has added the genera Lebiasina *Val.*, from Lima, Pyrrhulina *Val.*, from Surinam, and Umbra *Kram*, from Hungary. My genus Melanura is the North American representative of the European Umbra. It may be characterized as follows: Body elongated, compressed; dorsal far behind, extending over the space between the ventrals and the anal, as far back as the anal itself; ventrals when bent back reaching the anal. Mouth opening forwards; lower jaw longer than the upper, armed as the intermaxillaries and palatines with small recurved velvet teeth; no teeth in the upper maxillaries *which form the sides of the upper jaw;* pharyngeal teeth like those of the jaws, but smaller. Cheeks, opercle and top of the head covered with scales. A few large pores along the preopercle, the mastoids and on the top of the head. Gill openings very large; membrane connecting the four branchiostegal rays overlapping one another below. No Pseudobranchiæ. Caudal fin rounded. Hydrargyra limi, *Kirt.*, is another species of this genus, and Professor Baird has discovered others in our western waters, which he has forwarded to me for comparison and description.* The first species mentioned above, must retain the specific name given to it by Rafinesque. I shall therefore call it *Melanura annulata.* The little figure given of this species by Mr. Thompson, in his History of Vermont, p. 137, is very characteristic.]

CAMPOSTOMA, *Agass.*

As stated above, the Exoglossum dubium of Dr. Kirtland, though closely allied to the typical species first described by Lesueur is not generically identical with it.

It is true, its pharyngeal teeth have the same general arrangement, there being an outer row of four teeth on each side, and an additional small tooth within that row; but the teeth themselves inserted in a cluster abreast of the rather spur-like lateral dilatation of the pharyngeal, are more elongated, hardly hooked at all, and their inner margin presents a long narrow grinding surface, very similar to that of the genus Chondrostoma proper.

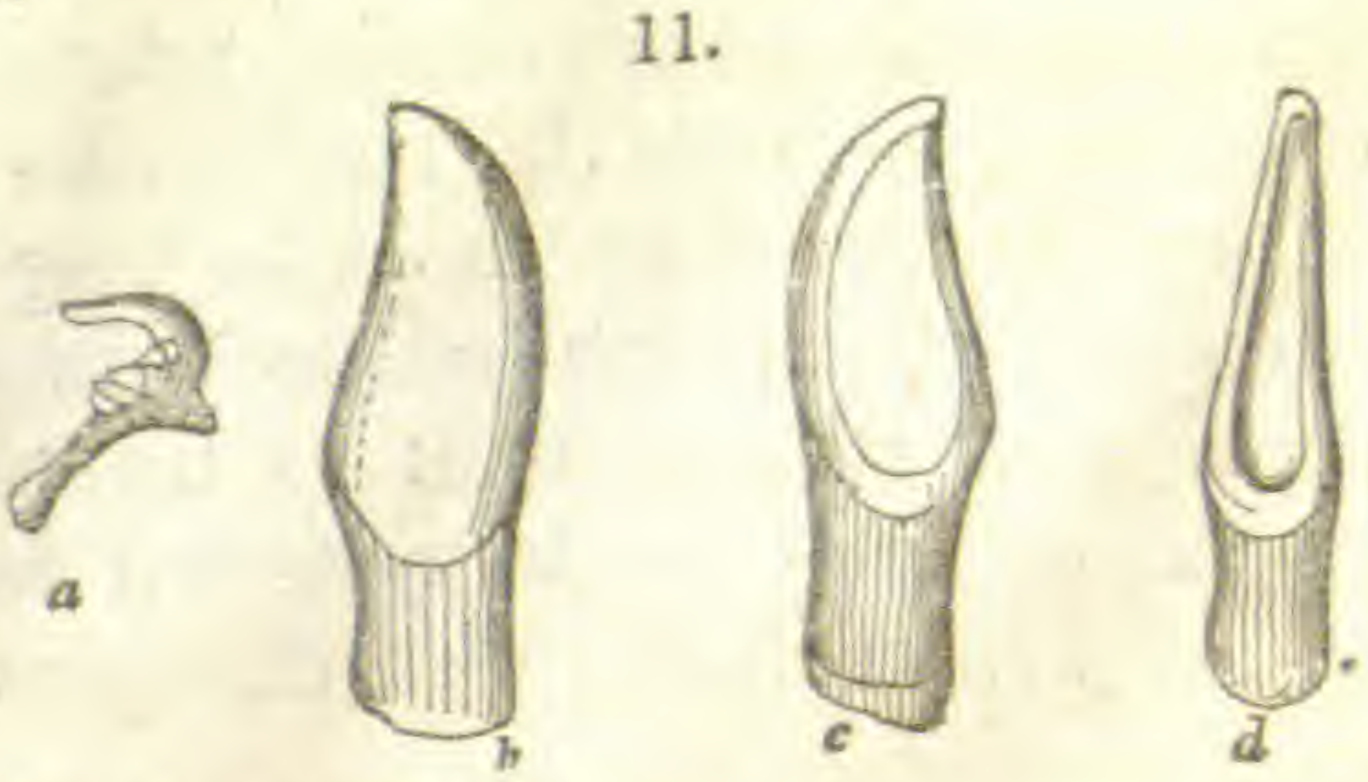
The American fish differs however, in having two rows of teeth, while Chondrostoma has six teeth in a single row. Besides, the form of the mouth is very different in the two, being square in Chondrostoma and arched in Exoglossum dubium.

* I have received another from Davenport, Iowa, through the kindness of Professor Sheldon. I shall describe all these fishes comparatively, on another occasion, and then discuss their synonymy more fully.

This shows plainly that however closely allied, they are types of different genera, and I shall introduce the name of Campostoma for the American form. The scales bear a close resemblance to those of Exoglossum; their longitudinal diameter however prevails over the vertical and the radiating furrows diverge more towards the posterior margin. The body is fusiform, rather stout, somewhat compressed; the peduncle of the tail long and powerful. Fins of medium size and rounded. Head broad, compressed; its sides vertical; eyes high upon the sides of the head, reaching its upper outline. The species I have mentioned in my notice of the fishes of the Tennessee River, under the names of *Chondrostoma prolixum* and *pullum** belong to this new genus, as also *Exoglossum spinicephalum* of Valenciennes. Since it is not my object to describe here the species of North American Cyprinidæ, upon which Professor Baird is preparing a monograph, I shall not enter into further particulars respecting this genus, remarking only that the species of Campostoma assume a very different appearance in different periods of the year, according to their sexes; Exoglossum spinicephalum of Valenciennes, for instance, being the male in its breeding dress of the same species Dr. Kirtland has described under the name of Exoglossum dubium. Leuciscus prolixus *Storer* again, is synonymous with *Ex. dubium* Kirtland. The young differ also greatly from the adults, and I have satisfied myself from a large collection of specimens of different ages and sizes sent me by Dr. I. H. Rauch, of Burlington, Iowa, that the fish I have described as Chondr. pullum, in a note to my notice on the fishes of the Tennessee River, is a very young specimen of the same species. It is but recently I have been able to identify this fish with one of Rafinesque's species. Knowing how common it is in our western waters, I could hardly believe he should have overlooked it, and yet it was not until I had made out most of his species I perceived that among the few remaining ones his Rutilus anomalus agrees in every respect with it. This name *anomalus* being by many years the oldest, must supercede all others, and the species shall henceforth bear the name of *Campostoma anomalum.* I would also consider Rutilus melanurus *Raf.*, as another synonym of this species, were the dorsal not described as having 15 rays. Some of the species described lately as Chondrostoma from the Old World may belong to this genus.

Fig. 11, *a*, represents the right pharyngeal of *Campostoma anomalum*, *b* and *c*, one tooth of the outer row from two sides, and *e*, the same from the inner side to show the grinding surface.

11.



* See this Journal, vol. xvii, p. 357.

Pimephales, Raf.

This genus was established by Rafinesque for the reception of a small species little known then as now to anglers. The single specimen from which he drew the generic as well as specific characters of this fish was taken at Lexington, Ky., with a small hook. The peculiar features of the fish mentioned by Rafinesque in his description, leave no doubt respecting its identity. The large irregular black spots of the anterior base of the dorsal, its first, simple, shorter, obtuse, hard ray, together with the blackish head and blunt snout, readily distinguish it from any other fish of the same family in the vicinity from which it is described. The generic characters as given by this naturalist, are: Body oblong, thick, and scaly, vent posterior, nearer to the tail, head scaleless, fleshy all over, even over the gill covers, rounded, convex above and short. Mouth terminal, small, toothless, with hard, cartilaginous lips. Opercle double, three branchial rays. Nostrils simple, dorsal fin opposite the abdominals, with the first ray simple and cartilaginous. Abdominal fins with eight rays. This generic diagnosis exhibits most of the defects of the greater number of such descriptions. To mention that the body is *scaly*, the *head scaleless*, the *mouth toothless*, the branchiostegal rays *three in number* is only to repeat as characters of one what in reality belong to all the genera of the family. I am sorry to add that this practice of referring at random to families, genera or species the characters observed, is continued to this day by the majority of our Naturalists. Most of their generic descriptions are only vague specific descriptions, and their specific descriptions refer chiefly to individual peculiarities of the specimens before them. They are at best a kind of portrait of particular individuals without much likeness.

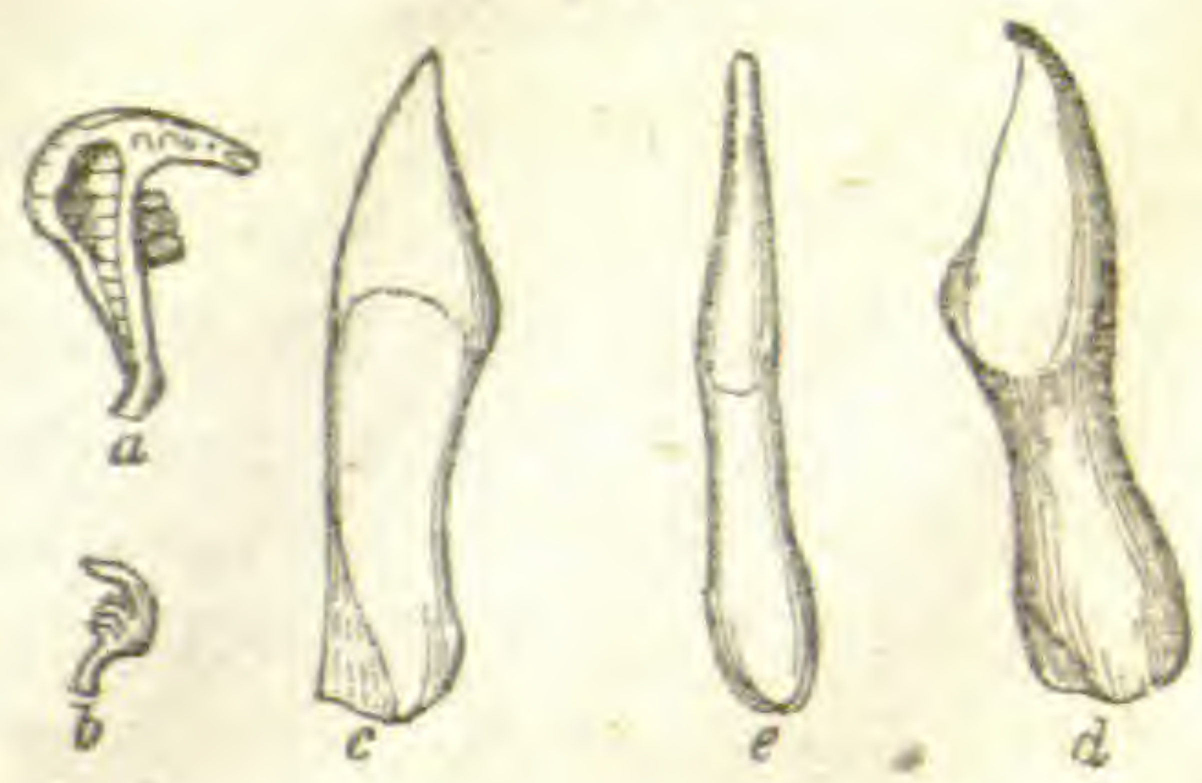
What Rafinesque says of the nostrils being simple is absolutely false, as in all Cyprinoids there are two openings of the nostrils on each side of the head; the upper one is crescent-shaped, the lower or anterior one oval; both close together.

The name proposed by Rafinesque is abbreviated from Pimelekephale, which means *fat-head*, an allusion to the round fat head. In the Ichthyologia Ohiensis, Rafinesque gives Flat-Head as the meaning of the name he proposes for the genus: but this is evidently a misprint for fat-head.

This genus is very closely related to Campostoma, in which however the scales on the back in front of the dorsal are as large and as well arranged as those behing this fin, while in Pimepheles they are very much reduced in size, crowded and irregular in form and arrangement in front of the dorsal. The spine in the dorsal, as well as the rounded form of all the fins are also characters which distinguish this genus from Campostoma. But what particularly characterizes this genus externally is the short, conical head, the height and length of which are nearly equal. The snout is broadly rounded both vertically and laterally. The mouth, which is terminal and not beneath the snout, opens slightly upwards. The lower jaw is short, arched in front and bent upwards, giving it a somewhat spoon-shaped form. At present, we know of only one species belonging to this genus, which Rafinesque described under the name of Pimephales promelas. He never saw more than one single specimen of this remarkable fish, which he obtained from Mr. W. M. Clifford, of Lexington, Kentucky, in 1820. It is not mentioned in the great Histoire Naturelle des Poissons, by Cuvier and Valenciennes. Dr. Kirtland, to whose indefatigable ardor we are indebted for so much valuable information upon the fishes of the Ohio, seems to be the only Ichthyologist who has noticed this fish from personal observation, since it was first described by Rafinesque. Dr. Kirtland describes it from three specimens caught in Trumbull County, Ohio. I have myself had the good fortune to obtain a large number of specimens in the smaller brooks west of St. Louis in Missouri. The species fully deserves the specific name given to it by Rafinesque on account of the contrast between the almost black color of the head and the light tint of the body. The largest specimens I have seen did not exceed three inches and a half in length.

Heckel, who has devoted more attention to the study of the pharyngeal teeth than any other Ichthyologist has gone so far as to consider their number of generic importance. To some extent this is true ; for I find that in some types of this family there is a remarkable constancy in that respect, though in others slight variations are observed. In the tribe of Chondrostoma for instance, the genera after being characterized by other structural peculiarities, present further differences in the form and number of their pharyngeal teeth, and even in the form of the pharyngeal bones. In Pimephales there are constantly four compressed teeth on each side, the inner edge of which presents a flat, narrow, grinding surface, while the outer edge is arched and terminates either abruptly or as a small hook curving over the side of the grinding surface. The spoon-shaped lateral dilatation of the pharyngeals is particularly prominent in this genus. Fig. 12, *a*, represents the right pharyngeal of *Pimephales promelas* enlarged from the outer surface to show this projection, *b* represents the same bone from the dental side, in natural size: *c* and *e*, are profile and side views of one of the teeth without hook,

12.

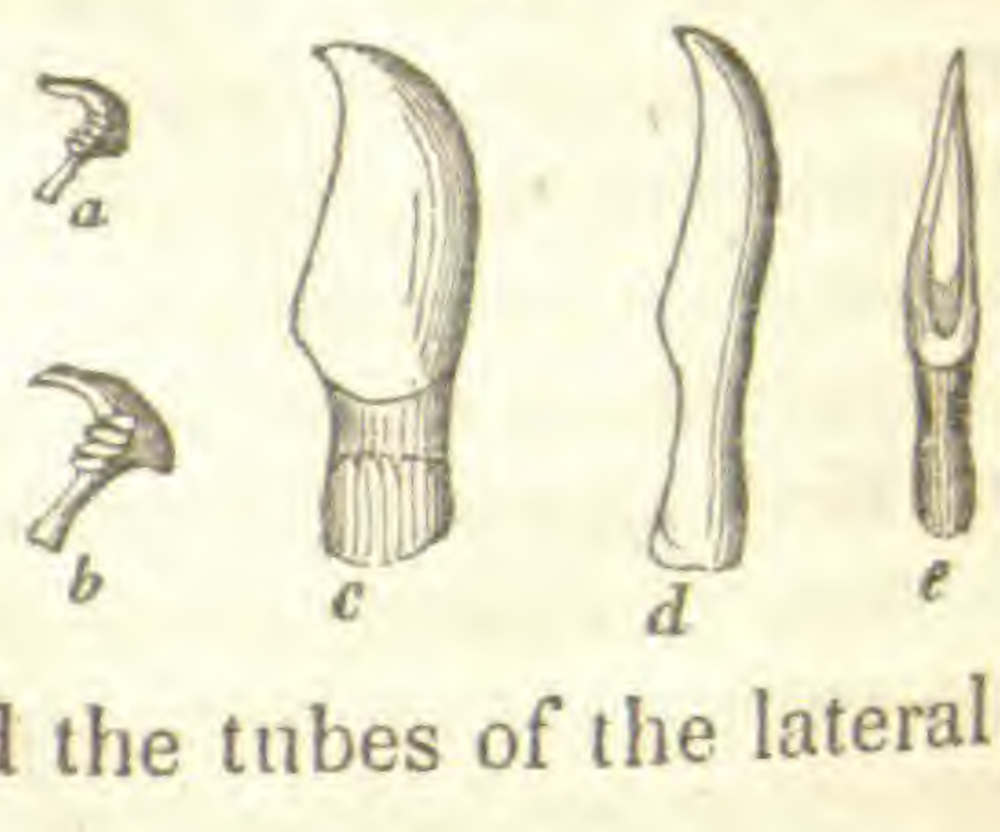


and *e*, one hooked tooth in profile. The scales of this genus are also very peculiar; their longitudinal diameter is much shorter than the vertical, as in *Plargyrus*, and the centre of radiation is much nearer to the anterior, than to the posterior margin; the concentric ridges of the ornamental layer of the outer surface are close together, and only interrupted by radiating furrows upon the posterior and lateral fields of the scales. The tubes of the lateral line short, broad and curved downwards upon the middle of the posterior fields of those scales.

Hyborhynchus, Agass.

In respect to the arrangement of the scales, and the structure, position and form of the fins, this genus does not differ from Pimephales; it is chiefly distinguished by characters of the head and the pharyngeals. The head is long and flattened above; the profile descends suddenly on reaching the nostrils, forming a very blunt, gibbous snout, (whence the generic name Hyborhynchus). The mouth is small, beneath the snout, and cut horizontally. The lower jaw is flat, broadly rounded in front and shorter than the upper jaw. The sides of the head are vertical and form with its upper surface an angle or ridge behind the eyes. The upper border of the eye reaches the top of the head. The pharyngeals have about the same form as in Pimephales, the symphysal process being only more straight, with a deeply emarginate side; the teeth cut vertically and not obliquely as in Pimephales, with a narrow, flat grinding surface and a slightly arched tip. Fig. 13, *a*, represents the right pharyngeal of *Hyborhynchus notatus* in natural size, *b*, slightly magnified, *c* and *d*, two teeth more highly magnified, seen in profile, and *e*, one seen from the grinding surface. The scales are higher than long, and the centre of radiation very forwards as in Pimephales; but the radiating furrows are not so numerous, and the tubes of the lateral line are narrow and straight.

13.



For the possibility of identifying one more of Rafinesque's species, I am indebted to the Rev. T. S. Fall, of Frankfort, Kentucky, who sent me specimens from the very locality where Rafinesque used to collect, among which I have recognised without difficulty his Minnilus notatus, *Raf.*, the type of my new genus Hyborhynchus. I had already received specimens of this fish before, through the kindness of Prof. Baird, from various localities in Pennsylvania and Ohio, under the name of Pimephales elongatus, which very correctly expresses the general affinities of this fish. I am indebted to J. Sullivant, Esq., of Columbus, for specimens from the Scioto River, to Dr. Watson for others from

Quincy, Illinois, to Dr. I. H. Rauch, for others from Burlington, Iowa, to Prof. J. M. Safford, for specimens from Lebanon, Tennessee, to Col. B. L. C. Wailes for others from Natchez, Mississippi; I have myself caught specimens at Beardstown and Lasalle, Illinois. I received from an unknown contributor, with many other species, one specimen from Rome, New York. I find it also among Professor Baird's specimens from Westport (Lake Champlain) and among mine from Lake Huron. This most extraordinary range is hardly covered by a single species, and yet I can find no specific differences between the specimens even from the most remote localities. I must remark however, that from some I have only a few rather indifferently preserved specimens.

Hybognathus, Agass.

In this genus the body is more of a fusiform shape than in Pimephales; the head is triangular or wedge-shaped, and the snout hardly blunt; the profile not descending suddenly on reaching the nostrils. The top of the head is convex and rounded at the sides instead of forming a prominent ridge. The mouth is small and terminal; the lower jaw is quite thin and flat; its symphysis is angular and prominent, being surmounted by a slight tubercle, in allusion to which I have called the genus Hybognathus.

The upper jaw partakes in a less degree of the angular outline of the lower jaw, which is shorter than the upper, and fits within it. The dorsal and anal fins, though similar in form, yet differ from those of Pimephales, in having the longest simple ray the longest ray of the fin, making the anterior and outer angle pointed. The pectorals and ventrals are slender and pointed; the caudal is deeply forked. The scales are as large on the back and anterior portions of the body as behind the dorsal and ventral fins. Scales subtriangular, owing to the greater vertical diameter, the prominent posterior margin and the very forward position of the centre of radiation.

Ornamental concentric ridges closer together upon the very narrow anterior field. No radiating furrows upon this, and the lateral fields, but only upon the posterior field; this however, being by far the greatest, the furrows appear rather numerous. Tube of the lateral line beginning forwards in the centre of radiation, but extending only to the middle of the posterior field. The pharyngeals have their lateral dilatation almost square, with an acute angle from the most projecting point; their upper end is club-shaped. Teeth, four in one row, of the same form as those of Campostoma.

14.

Fig. 14, *a*, represents the right pharyngeal of Hybognathus in natural size, *b*, enlarged, and *c* and *d*, one tooth in profile and from the side, still more magnified.

Hybognathus nuchalis, Agass.

For specimens of the species which constitute the type of this genus, I am indebted to Dr. Watson of Quincy, Illinois. I have also received some from Dr. Rauch of Burlington, Iowa, and others from Dr. Engelman of St. Louis, Missouri. The largest specimens are nearly four inches long. The dorsal and ventral outlines are arched equally. The length of the head is one-fifth of the entire length or a little less than the greatest height of the body. The eye is of moderate size, and slightly elliptical in form, its hinder margin is nearer the posterior angle of the opercle than the end of the snout. The opercle is higher than long, its lower border is convex, the posterior emarginate. The upper maxillary does not reach the vertical line of the anterior border of the eye. The dorsal begins at the highest part of the back slightly in advance of the ventrals; its height is greater than its length, and is not emarginated behind; its last ray as to length, is to the longest ray of the fin as 1 to 2. The anal fin is one-third smaller than the dorsal. The lateral line is straight, except over the pectorals, where it bends upwards, and ends above the opercle. There are four rows of scales between this line and the ventrals, and five above it.

Back, dark olive color, with a darker stripe from the neck to the base of the dorsal, extending also along the back, between the dorsal and the caudal. A greyish, diffuse, longitudinal band above the lateral line; sides silvery.

P. 1, 14; D. 2, I, $6\frac{2}{1}$; V. 1, 7; A. 2, I, $6\frac{2}{1}$; C. 4, I. 9, 8, I, 5.

In the method adopted by Valenciennes, all the fishes of the family of Cyprinoids described above from the North American continent, would be referred to his genus Sclerognathus, to Catostomus proper, to Exoglossum and to Chondrostoma. His *Sclerognathus* would include Rafinesque's genera Carpiodes and Ichthyobus, and my Bubalichthys; *Catostomus*, as he limits the genus, would cover Cycleptus, Moxostoma, Ptychostomus, Hylomyzon and Catostomus proper. Whether Exoglossum would be made to include my genera Hyborhynchus and Hybognathus, or whether these would be referred by him to my genus Chondrostoma, I do not know; Campostoma, which is much nearer to Chondrostoma, being already referred to Exoglossum would probably carry with it Hyborhynchus and Hybognathus, and yet these types are much more closely related to Chondrostoma than to Exoglossum; but such inconsistencies are everywhere the unfortunate results of a loose identification of genera. I have no doubt however, that my genus Acròcheilus would be considered by every Ichthyologist as nearest akin to Chondrostoma. All the genera of North American Cyprinidæ not yet enumerated above have been referred by Valenciennes to his genus *Leuciscus*, which in my estimation is a mixture of heterogeneous types, and must be subdivided not only into genera, but even into tribes. But before expressing any opinion upon the closer affinities of these more restricted genera it is advisable to illustrate successively their structural characters and to compare them with one another. I begin with

Chrosomus, Raf.

The genus Luxilus of Rafinesque embraces two different types, which he has himself separated as subgenera under the names of *Chrosomus* and *Luxilus* proper. These two types differ in so many structural peculiarities that I do not hesitate to consider them as different genera. These differences are indeed so obvious, that DeKay, though he does not refer to Rafinesque's groups, has elevated to the rank of a distinct genus which he calls *Stilbe*, the type which Rafinesque calls *Luxilus* proper, whilst Heckel has given it a third generic name, calling it *Leucosomus.**

Kirtland is the only American Ichthyologist who has paid due regard to the work of Rafinesque upon our western fishes, and we find in consequence the species now under consideration described by him as *Luxilus erythrogaster*, he not having deemed it necessary to enquire into the merits of the subgenera Chrosomus and Luxilus proper. Kirtland however erroneously introduces a genuine *Alburnus* into the genus Luxilus.

Storer refers *Luxilus* erythrogaster to the genus *Leuciscus*, without giving his reasons for the change.

I shall of course, retain Rafinesque's name *Chrosomus*, for the type of Luxilus erythrogaster and that of *Luxilus* for the other type, which embraces at the same time the genus *Stilbe* of DeKay and the genus *Leucosomus* of Heckel. It is more difficult to trace the generic differences distinguishing *Chrosomus* and *Phoxinus* as they are very similar in external appearance; yet upon careful comparison such differences are observed between them, that no doubt can remain respecting the propriety of considering them as distinct genera, if structural peculiarities are at all indicative of generic differences. In the first place Phoxinus has two rows of pharyngeal teeth, the outer, numbering four or five teeth, the inner, one or two, whilst Chrosomus has only one row of five teeth. Moreover, in Phoxinus the point of the teeth is strongly hooked, and their inner margin entire, while in Chrosomus that margin is flattened into a grinding surface, the teeth terminating however with a small hook.

* It may not be out of place to remark here that *Cyprinus Smithii* of Dr. now Sir John Richardson, upon which Heckel has founded his genus *Glossodon* is nothing else but our common *Hyodon*.

15. 16.

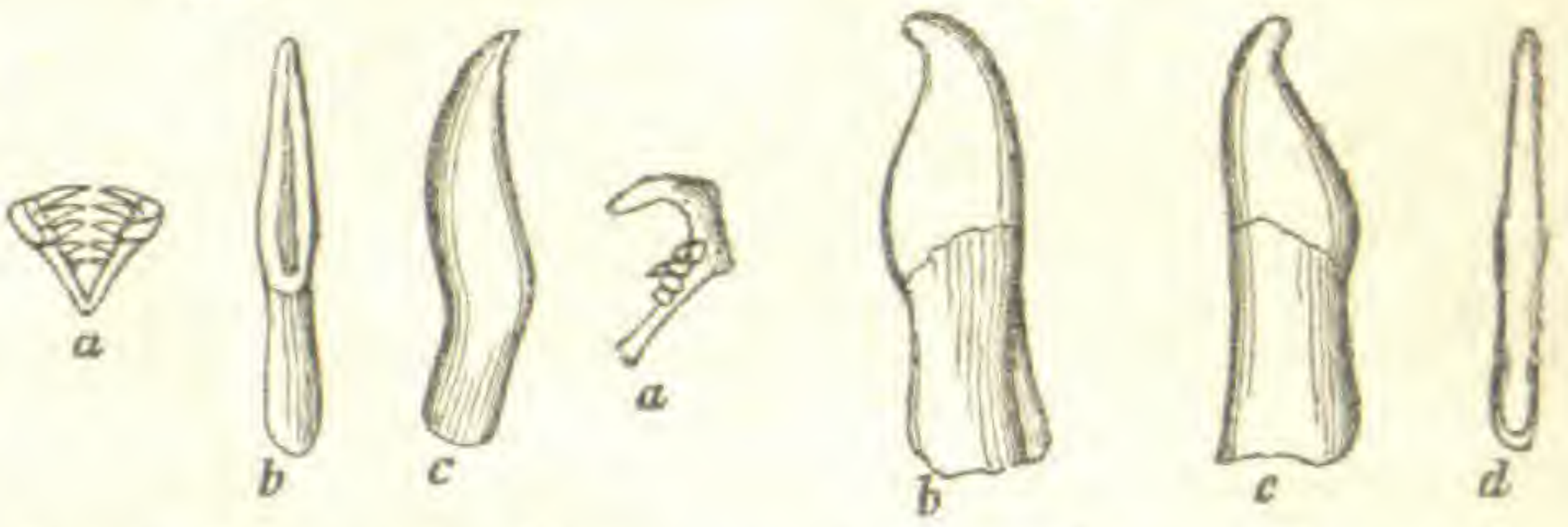


Fig. 15 and 16 represent the pharyngeals and teeth of these two genera side by side: 15, *a*, the right pharyngeal of Chrosomus erythrogaster, *b* and *c*, one tooth in profile and from the grinding surface. Fig. 16, *a*, the right pharyngeals of Phoxinus varius of Europe, *b*, *c*, *d*, a tooth of the outer row from three sides.

In my paper upon some new species of Cyprinoids from the Lake of Neuchatel, printed in 1835 in the Transactions of the Natural Historical Society of that city, I characterised the genus Phoxinus as follows: "Body cylindrical, stout, covered with very small scales. Pharyngeal teeth pointed. Caudal furcate." Heckel in his Ichthyology of the Travels of Russegger, has added the following particulars: Dentes raptatorii 2–5; 5–2. Os anticum; labia teretia; cirri nulli. Pinna dorsalis et analis brevior, illa pone pinnas ventrales incipiens. Squamæ minimæ membranaceæ, adherentes, vix se invicem tegentes.

The facilities I have had for comparing Phoxinus and Chrosomus, which are representative genera, respectively limited to the Old and New World, enable me to furnish further information upon their peculiarities, which is the more needed as the description of Rafinesque is very brief and incomplete.

The bluntness of the head and the shortness of the cylindrical body of Phoxinus is very characteristic and contrasts in a striking manner with the more pointed head and fusiform body of Chrosomus. In both these genera the scales are very small, thin, membranaceous and hardly appressed to the body, which circumstance has misled Heckel into the statement that the scales hardly cover one another; yet they are imbricated in the usual manner; but they are not arranged in quite so regular rows as in most other genera. Phoxinus and Chrosomus are in fact with Moxostoma the only groups I know in the family of Cyprinoids in which the lateral line is not regularly continuous from the upper angle of the opercle to the base of the caudal. In Phoxinus it breaks up for the most part, not far behind the tip of the pectorals, but reappears generally above the ventrals for some short space, and here and there single perforated scales may be traced to the end of the tail; in Chrosomus it is more continuous, extending usually without interruption as far back as the space between the ventrals and the anal, and then more interruptedly backwards. The scales themselves differ so far that they may be recognized, even when isolated; in Chrosomus the concentric ridges upon the surface of the ornamented layer of the scale are closer together and interrupted at regular intervals in every direction from the centre, in such a manner as to give rise to radiating furrows diverging on all sides In Phoxinus the ridges are fewer, and they are only distinctly interrupted upon the posterior and lateral fields of the scale, and scarcely at all upon the anterior segment, so that the anterior margin exhibits few furrows, if any. The tubes of the scales in the lateral line are also different. In Chrosomus they are narrower, more tubular and closed, and not extending far beyond the centre of growth of the scales; in Phoxinus they have the appearance of broad channels occupying almost the entire field of the scale from margin to margin. The number of teeth assigned to Phoxinus by Heckel is not quite so constant as he seems to believe; I find occasionally only four teeth in the outer row instead of five, and only one in the inner row instead of two; but I have never seen two rows in Chrosomus. The form and comparative size of the fins are about the same in the two genera; they differ only in relative position, the dorsal being placed farther back in Phoxinus than in Chrosomus. The mouth is terminal and yet when it is closed, the snout projects slightly beyond its crescent shaped outline; this feature is particularly marked in Chrosomus. However, when the mouth is opened the lower jaw of Chrosomus projects more than that of Phoxinus. Neither of these fishes have barbels. In Chrosomus as well as in Phoxinus, the males differ from the females in having brighter colors, especially in the spawning season.

The ***Rutilus ? ruber*** of Rafinesque, which he has himself never seen, and of which he says that it may belong to his genus Rutilus, *or to any of this tribe*, a slender fish, only two inches long, compressed and of a *fine purple red*, can be nothing but Chrosomus erythrogaster. There is no other fish in the Ohio basin answering to this description.

Ptychocheilus, Agass.

There are few Cyprinidæ in which the mouth is widely cleft; few which have a slender appearance and whose form indicates swift motion. Among the best known of that character I may mention Aspius rapax from the Danube. The new genus which I am about to describe, has however, this appearance in a very eminent degree; and, though it would not appear safe to establish a new genus among Cyprinidæ from a single specimen deprived of its intestines and of its pharyngeal teeth, and which, in such a state, affords very imperfect means of comparison, I have however, not the slightest doubt that the fish before me cannot be referred to any of the many genera which have been established among Cyprinidæ. Its mouth is far more widely open than that of any Cyprinoid known to me, and its lips are very fleshy, especially the upper lip, the inner surface of which is deeply folded so as to present radiating folds all round its edge when the mouth is open. The lower lip is also very fleshy around the symphysis of the two branches of the lower jaw, and presents the same folds; but, upon the sides it tapers into a thin membranous fold deeply separated, by a furrow, from the skin covering the lateral branches of the lower jaw. This fold unites at the lower extremity of the intermaxillary bone, and presents in many respects a remarkable resemblance to the folds of the membrane of the lower jaw in Murænidæ. The skin covering the tongue and extending between the inner sides of the two branches of the lower jaw, is also remarkably folded. As such characters occur in no other genus, I am well justified in considering this as a peculiar type of the family. There is not the slightest indication of a tentacle at the angle of the mouth between the intermaxillary and upper maxillary bones.

The branchiostegal rays, three in number as usual, seem at first rather short, and broad, but, upon close examination it is found that behind and above the part of these bones which is seen externally, there is a long prolongation arising behind the suboperculum, thus giving additional strength to the gill covers. The branchiostegal membrane unites with the chin in advance of the humerus, so that the branchial fissure does not extend to the side of the hyoid bone.

One of the most striking features of the fish is the great elongation of the head, which, in outline, truly resembles that of Lucioperca. The body is cylindrical and slender, tapering slightly toward the caudal, so that the tail is very strong and powerful, affording another evidence of the energetic movements this fish can perform. The dorsal and the ventrals are rather backwards; the ventrals much nearer to the anal than to the pectorals. The pectorals are rather large and elongated, and by no means so broad proportionally as the ventrals. They consist of one hard ray, and sixteen articulate rays, the two lowest of which are simple. In the ventrals there is in advance one simple ray, followed by eight branching rays. In the dorsal, which has the same form as the anal, there are two small rays in advance of the large simple one followed by eight branching rays, the last of which is a double ray. The anal has the same structure, but there is one ray less. In these two fins, when shut, the rays overlap each other. This is also the case with the central rays of the caudal, in which there are nine branching rays in the upper lobe, and eight in the lower. A large simple ray on each margin and seven or eight small rays near the base. The lateral line considerably curved behind the operculum, follows at first the middle line of the body, but is nearer the abdomen than the back, upon the sides of the abdomen, and resumes its medial position upon the tail. The scales have the ordinary appearance of Leuciscus scales, but are rather smaller than in the common Leucisci. It is a great pity that neither pharyngeal bone nor intestines have been preserved so that the relation of this fish to the ordinary Leucisci cannot be well ascertained.

I have preserved the characteristic of this genus as I had written it four years ago when I had only the specimens of the Exploring Expedition before me, without any trace of pharyngeals or intestines, that I may be able better to show how correctly we may judge of certain structural peculiarities not within our reach from other facts we may have observed. The predatory habits of the type of this genus were inferred from the form of its body and from the shape of its mouth. Now we know also the teeth from another species sent me from San Francisco by my friend T. G. Cary, Jr., Esq., the case is perfectly plain and I am confident in asserting that the species of Ptychocheilus are among the most voracious of the whole family of Cyprinoids, exceeding probably all others in their rapacious dispositions.

17.

Fig. 17, *a*, represents the right pharyngeal of Ptychocheilus major, from behind; *b*, one of the teeth of the outer row magnified twice.

Ptychocheilus gracilis, Agass. & Pick.

The back bluish grey. Silvery upon the sides. Head and cheeks golden color. Fins yellowish orange. The middle of the caudal grey.

From Willamet Falls, Oregon.

Ptychocheilus major, Agass.

I am unable to indicate the colors of this species, but it is easily distinguished from the preceding by its larger scales.

From San Francisco, California.

Mylocheilus, Agass.

It seems to be a characteristic feature of the Cyprinidæ of the Columbia River, to have their mouth clothed with a hard grinding sheath similar to the horny covering of the Turtles. We have seen the Acrocheilus provided with a flat horny chevron upon its lower jaw, and a similar but narrower sheath upon the inner margin of the upper lip. In the genus Mylocheilus the mouth has a different shape. At first sight it does not differ at all from that of the common Leucisci, or rather from the type which represents the European Leucisci on the shores of North America, and of which Dr. Storer's Leuciscus pulchellus is this type, which differs from the European Leuciscus in having a small tentacle, like the European Gudgeon upon the angle of the upper jaw between the extremity of the intermaxillary and upper maxillary bones. In addition to this peculiarity which our Mylocheilus has in common with the Eastern American Leucisci, our fish has a horny sheath surrounding both the upper and lower jaw, so that we are led to consider it without hesitation as a new generic type, peculiar, as far as we know at present, to the Northwestern coast of America. A close examination of the pharyngeal system of teeth fully sustains the impression, first received from the examination of the jaws, that Mylocheilus constitutes a distinct genus in the family of Cyprinidæ; for its teeth differ entirely from those of the common Cyprinidæ known at the present day. Far from having the slightest resemblance to the teeth of either the European or East American Leucisci, its teeth resemble more those of the true Carp's in being large and rounded, while the Leucisci, which it most nearly resembles in external appearance, have their teeth conical, pointed and hooked at the tip. However, these teeth differ from those of the genus Cyprinus proper in having a flat rounded crown without sulci and gyri. These teeth are arranged in one main row of five, in which the anterior teeth are the largest, and the posterior are much smaller and somewhat compressed and hooked. One tooth is wanting in the left row, but its base of insertion shows that it has recently fallen off. In addition to those teeth, there is above on each side one small tooth similar in form to the common small tooth of Leucisci; underneath on each side, one or two immature teeth sticking in the gum. Were it not for the circumstance that the two arches of the pharyngeal bones are free and movable upon their symphysis, one might suppose this apparatus to have belonged to some Labroid Fish; so great is the resemblance of its rounded teeth to those of that family. The horny plate against which this apparatus moves upon the basilar bone is ovate, lanceolate. The arches of the gills are provided, on their inner margin with tufts of small teeth forming canals which alternate between the adjacent arches, the upper ones of the first arch only consist of strong hooks. The nostrils are large; the anterior, tubular; the posterior crescent-shaped.

Water-pores seem to be fewer than in Acrocheilus. I perceive only those larger ones which follow the shoulder bone, the mastoid, the preoperculum, the suborbital, and the lower jaw. The branchiostegal membrane unites in advance of the humeral bone, so that the branchial fissure does not extend to the side of the hyoid bone. The pectorals are large, and longer than the ventrals, the latter placed nearer to the anus than to the pectorals. The dorsal begins in advance of the ventrals which are opposite the middle of that fin. There is one strong simple ray, in the anterior margin of the pectorals, followed by seventeen branching and articulated rays, the last of which however are simple. The ventrals consist of one simple ray and eight branching ones.

When shut, the rays of these fins are brought close together, but do not overlap each other as is the case with the rays of the dorsal and anal and with the middle rays of the caudal. The dorsal has a narrow base, as has also the anal, both fins having the same structure, differing only in size. There are two small rays in advance of the long ray of the dorsal, followed by seven branching rays the last of which, however, is a double ray. The anal has precisely the same number of rays. The caudal is large, furcate, and has eight smaller rays along the upper and lower margin; then, on each side, a large simple ray. The upper and lower lobes are apparently equal; there is, however, one ray more in the upper lobe, that is to say, nine above and eight below. The inner ones overlap each other when the fin is shut. The scales are of medium size and have the common appearance of Leuciscus scales. The lateral line slightly bent downwards behind the operculum, follows about the middle of the side. The intestine has twice the length of the abdominal cavity, and is a simple tube tapering from the stomach backwards. The air bladder as usual, consists of two divisions with a tube opening into the pharynx. The humerus forms a widely rounded angle above the pectorals.

18.

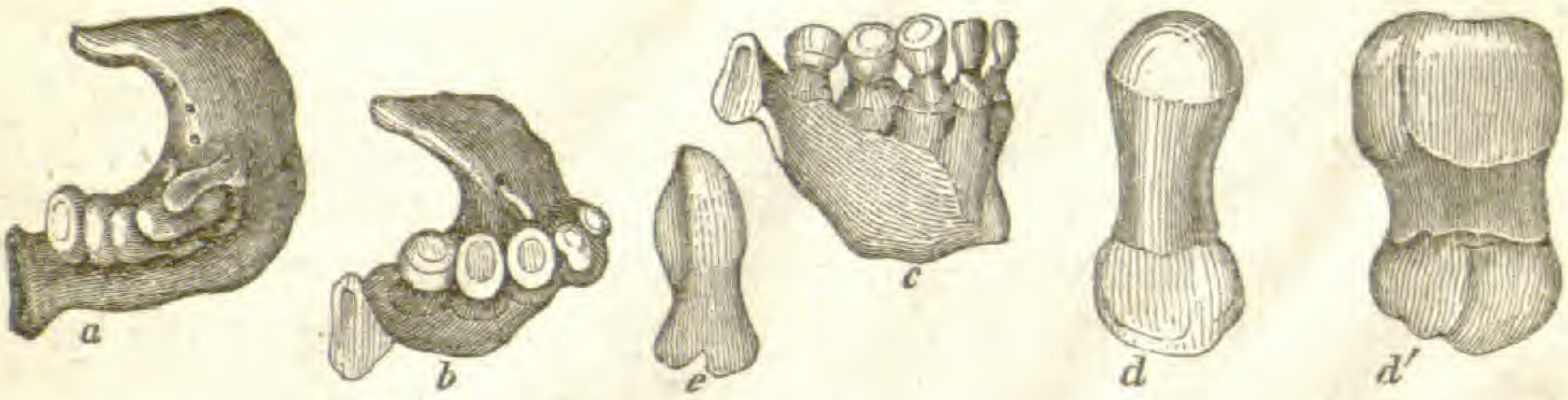


Fig. 18, *a*, represents the right pharyngeal from behind, *b* from within so as to show the crown of the teeth from above, *c* represents the same in profile to show the insertion of the teeth; *d* and *d'*, represent the same tooth, the second above the symphysis, from two sides showing how much it is compressed; *e* is a side view of the outer or upper tooth of the main row.

Mylocheilus lateralis, Agass. & Pick.

Greenish blue above with a reddish line upon the sides. Upper fin greenish. The edge of the caudal reddish. Pectorals and ventrals orange. The horny plate of the mouth is of a brownish orange.

Caught in the Columbia River at Fort Vancouver in Oregon.

(*To be continued.*)

ART. XXIII.—*Discovery of a Coal Basin on the Western borders of the Lake of the Woods;* by HENRY R. SCHOOLCRAFT.

FACTS observed during the several expeditions to ascertain the sources of the Mississippi river in 1820, and in 1832, under the authority of the government, denote this stream to originate in the geological drift, or erratic block stratum, resting on silurian strata. This drift composes a wide crescent-shaped range of high lands, sweeping round from the Otter-tail lake to the sources of the St. Louis river of Lake Superior, which constitute the northern rim of the valley. It forms a well defined water-shed, which pours its drainage south into the Gulf of Mexico north into the great Lake Winnipek; and southeasterly into Lake Superior. The French denominate it *Hauteur des Terres.* From the principal lake, which occupies its summit, it has, since the era of the last expedition referred to, been called the Itascan summit or water-shed. Mr. Nicollet who ascended it, in 1836, found its extreme altitude to be 1680 feet above the Gulf of Mexico.

The surface consists of immense heaps and wave-like deposits of oceanic sand, and comminuted sandstones and schists, with boulders of both the sedimentary and igneous rocks. Although the silurian series are generally concealed by these deep and wide-spreading deposits of the drift era, yet, they appear in horizontal positions at the Naiwa rapids at the foot of the Itascan range; on the Metoswa rapids, below Queen Anne's Lake; and, very distinctly at the Pakagama Falls, at the foot of the great sphagnous plateau below the inlet of Leech Lake river.

The whole column of formations is manifestly supported by the igneous group of rocks, heavy boulders of which lie tumbled together in many of the sub-valleys, as if they could not have been transported far from their parent beds. Whether the silurian strata be, however, imposed directly on the igneous, or exist in juxtaposition with them, is not certain. This only can be stated, in regard to the general arrangement, that in descending the channel of the Mississippi from Itasca Lake, the sandstones, grits, and quartzite are encountered at the localities mentioned. At a point, where the river has worn its channel 550 feet into the geological formations, (Dis. Sources Miss., p. 582,) the pyrogenous rocks are found in place, in its bed and on its banks. Such are the appearances near the influx of the river De Corbeau, in latitude 46°, and below that point. Rocks of igneous character have crossed the track of the Mississippi below this point—covering a belt of about one degree of latitude in width—that is to say, from the small river Nokasippi, near the Crow Wing branch, to the influx of the Sac or Osakis. Mr. Norwood, in his geological visit in 1848, did not find rocks in place above the De Corbeau, and did not ascend the river above Sandy Lake inlet. (Owen's Geol. Rep. of 1852, p. 293.)

These preliminaries will enable the reader, better to comprehend the following remarks. In mere point of altitude, the Itasca summit is not above the coal measures on the Alleghanies, which, by the best atlases, do not exceed sixteen hundred feet. (Black's Atlas, Edin.) The basin of the Lake of the Woods, is, however, at a lower point, occupying one of the northern plataux of this continental water-shed. Reports of the existence of coal in this remote basin, while I resided in the West,—taken in connection with the specimens of its mineralogy, brought to me from time to time, by the aborigines, did not sustain the conclusion. Nothing of the kind had been observed by the Commissioners and Surveyors, acting under the treaty of Ghent, who visited the lake to establish the national boundary, in 1823. Among these officials, were Maj. Joseph Delafield of New York, and Dr. John Bigsby of Nottingham, England—both zealous students of natural history. The only rock-specimen brought to me by the aborigines, proved to be a species of black steatite, a material which is much valued, by them, in their pipe sculpture and this afforded no evidence of the propinquity of coal-bearing strata. Neither were such strata observed by the late Mr. Keating, who accompanied Maj. Long in his expedition through the lake in 1823.

The first evidence of the silurian rocks in that quater, comes from Dr. Richardson, who passed through that lake in 1848, in the search after Sir John Franklin. He observes that in crossing the pyrogenous summit* between Lake Superior and Lake Winnipek, in the direction of the Rainy Lakes, silurian strata occur on both flanks of it. He further observes, that Dr. John Bigsby presented a species of Pentamerus to the British Museum, which he had procured at the Lake of the Woods. He informs us that the eastern margin and island of that lake, are granitic, and hence infers, with good judgment, that Dr. Bigsby's fossil was probably found on an arm of its western coasts. (Arctic Searching Exp., p. 47)

It is on the western coast of this lake, that recent information of a reliable character assures me, that large deposits of coal exist. The formation lies south of the national boundary line of 49° which crosses the Portage du Rât.

It is not the result of experience, to pronounce a country absolutely barren of resources, which has an uninviting aspect, but which is at the same time, unexplored, or imperfectly explored. The importance of coal in that quarter of the continent can hardly be over estimated. Immense tracts of fertile plains, without forest or fuel, exist along the valley of Red River, at Pembina, and

* He infers the summit to be a development of the beds of granite of the Thousand Islands, at the head of the St. Lawrence.

at points north of it, to which such a discovery must be of inestimable value. These extend south, quite to the St. Peters, or Minnesota, up to which, the transportation would be wholly by water. By the route of the Rainy Lakes, and the old Grand Portage to Pigeon River, the article could be readily introduced into the basin of Lake Superior for mining and smelting purposes. The absence of coal and the deficiency of wood in that quarter, now drives its ores and metallic masses to very distant points to be smelted.

Washington, Dec. 9, 1854.

ART. XXIV.—*Abstract of a Meteorologial Journal, for the Year 1854, kept at Marietta, Ohio;* by S. P. HILDRETH, M.D.

MONTHS.	THERMOMETER. Mean temperature.	Maximum.	Minimum.	Fair days.	Cloudy days.	Rain and melted snow. Inches.	Hund's	Prevailing Winds.	BAROMETER. Maximum.	Minimum.	Range.
January, . . .	30 66	69	2	14	17	3	25	W. & S. W.	30·00	28·80	1·20
February, . . .	37·66	59	14	19	9	2	33	S. W., S. & E.	29·80	28·80	1·00
March, . . .	47·55	73	19	20	11	4	25	W. & N. W.	29·65	28·80	0·85
April, . . .	49 66	85	22	15	15	5	42	W., S. W., N. E.	29·90	29·00	0·90
May, ...	62·50	95	34	20	11	2	12	S., N. & E.	29 75	28·90	0·85
June, ...	70·33	93	43	19	11	3	66	W. & N W.	29·55	29·05	0 50
July, ...	76·66	98	56	28	3	2	04	S. W. & N. W.	29·60	29·35	0·25
August, . . .	73·66	95	50	26	5	3	66	N. W. & E.	29·55	29·35	0·20
September, . .	69·96	97	42	24	6	2	16	W., N. W. & S.	29·88	29 12	0·76
October, . . .	58·13	81	31	16	15	4	32	W., N. & E.	29·80	28·85	0·95
November, . . .	41·33	66	22	17	13	2	29	W. N. W.	29·85	28·55	1·30
December, . . .	32·22	55	8	13	18	3	00	N. W. & W.	29·70	28·90	0·80
Mean for the year, .	54·20			231	134	38	80				

Remarks on the year 1854.

THE year just closed has been one that will long be remembered for several striking features; the most prominent of which were the long continued and excessive heat, accompanied by unexampled drought. No preceding year has witnessed such; embracing so vast an extent of country and so unremitting in severity. It ranged in longitude from the foot of the Rocky Mountains in the West, to the state of Maine in the East, and in latitude the region of country between the parallels of 32 and 42 degrees. In this space it was felt with the greatest severity; but varying somewhat in intensity, in different localities. The central portions of Iowa, Illinois, Indiana and Ohio seem to have sustained the focus of its force. Collections of water, and the courses of rivers, apparently ameliorated its destructive effects, by attracting occasional showers along their borders. This was evidently so in the southern portions of Ohio where showers were so distributed as to produce good crops of Indian corn; especially in the vicinity of the Ohio and Muskingum rivers. In the hilly portions of the state, where the soil is argillaceous, and the ground not ploughed more than five or six inches deep, there was nearly an entire failure of this staple crop.

The superior advantages of deep and thorough tillage was never more strikingly seen than in the results of this year. The potato crop was a failure; as much from the excessive heat of the summer, as the drought; the tubers being in many instances partly cooked, becoming soft and spongy in texture. The result was the almost entire destruction of this important article of food, and raising the price to a higher figure than known since 1838, when the potato disease prevailed so extensively. The wheat crop was excellent over all the western states; having attained its growth before the severity of the drought commenced. In some districts the grain was entirely destroyed by insects; the wheat fly or miller (Tinea granella), a species different from the Hessian fly, or (Cecidomyia destructor) which attacks the plant in the culm, or stem near the ground; while the miller deposits its egg in the newly formed grain, and the larva eats and destroys the farinaceous portion, leaving only the cuticle, and the kernel an empty shell. If the season is cool the destruction is accomplished after the crop is reaped and stowed away in the stack or barn; but if the weather is quite hot, the mischief is done in the field, and thousands of acres this year, in the central portions of the state were left untouched by the sickle. The grass crop was good, attaining its growth before the want of rain was felt; but the pasturage in the latter part of the summer was a failure. Sweet potatoes, now an important crop in Southern Ohio, were less than usual in quantity, but of a most excellent quality. The long continued heat being congenial to their habit, and perfecting the saccharine portion of this delicious esculent, in an unusual degree. The fruit crop was rather a failure, small in amount, and inferior in quality. The heat changed winter apples into autumnal ones; causing them to decay at a much earlier period than heretofore.

The grape crop was less injured by the drought than almost any other; its greatest enemy was the Curculio; but yielded a fair average of fruit. As an evidence of the wonderful compensating power of Providence, in the laws which govern vegetation, by restoring the loss of one production in the increased amount of another, the natural fruits of the forest were unprecedented in amount and quantity. The golden age so much landed by the ancient poets, seemed about to be again restored, in the immense quantities of acorns and other nuts. Many oaks being so loaded with fruit as to bend the branches nearly to the earth. On these the hogs luxuriated and fattened, in a wonderful manner; so that many farmers, whose corn-fields returned nothing for their labor, had cause to thank God, for such an abundant supply of nutritious food in this season of scarcity. Hogs and sheep prefer nice white oak acorns to corn, as more agreeable to them, and fattening them full as certainly.

Temperature.—The mean temperature for the year is 54°·20, being an increase of 1·46 degrees over that of 1853, and 2 above the mean heat of this locality. From the long continued warmth of the summer and early autumn, we should be led to expect a higher rate than we actually find; but the seasons are so governed by the permanent laws of climate, that no very serious, or injurious changes can take place.

Rain.—The amount of rain and melted snow was $38\frac{80}{100}$ inches which is more than the excessive drought of summer would seem to indicate; showing also in this respect the permanency of the laws of distribution of moisture and the descent of aqueous vapor, that arises by evaporation from forests and the surface of the earth. The mean quantity for a year will probably remain nearly the same but may be differently distributed amongst the several months; less in summer and more in the winter and spring, requiring in some portions of the west the construction of reservoirs for irrigation during summer droughts, as is practiced in New Mexico and some countries in Asia. The Ohio river became unusually low by the last of June, so that navigation was much impeded. During the summer months and all the autumn, business on the river in a manner ceased, greatly to the loss of manufacturers and traders. Immense quantities of iron and coal lay piled up on the banks of the Ohio, until the ice closed the river, early in December. Flat boats with produce could not float to their usual markets below; the yards of dealers in coal and fuel were exhausted in the cities and towns that depend on navigation for a supply and great suffering was the consequence of this low stage of water for so long a time.

Winter.—The mean of the winter months was 33°·13—which is rather mild. The mercury sunk to 8° above zero in December and to 2° in January, which were the extremes. During this season there fell about nine inches of snow, at different times; the greatest fall being not over six inches. It was a singular fact that the deepest snow, eight inches, fell on the 17th day of April; and at head waters about Pittsburg, over a foot. Also on the 29th of the month at Marietta, four inches, a very rare occurence.

Spring.—The mean temperature of spring was 53°·24, which is above the average. The supply of rain was abundant, being nearly twelve inches, or about one-third of the amount for the whole year. In April there fell with the melted snow five and a half inches, furnishing a liberal supply for the growth of early crops, such as grass and wheat.

Summer.—The mean of the summer months was 73°·55, which is three degrees above the mean average, but only one degree above that of the last year, which was very hot. There was some change in the distribution as to months, June having only 70°·33 this year, and 74°·60 in 1853; while July in 1854, had 76°·66, in place of 71°·15, in the preceding year. August varied less; being 73°·66 in place of 71°·55. During some of the hottest days in July, the temperature was 98° on the north side of my house, protected by the shade of a tree; and 140° in the direct rays of the sun. Under thick shady trees it rose to 100°, and continued all night above 90°, in the dwelling house, in several places. "Hot enough to roast eggs," is an old vulgar saying. I tried the experiment—a common hen's egg was painted black, put in an iron vessel and placed in the rays of the sun at noon. In two hours the white was cooked quite thick—the yolk in the centre not much changed. An acquaintance of mine blistered the ball of his thumb by picking up a small iron bar, that had been lying in the sun's rays. Many fields of late planted corn were much damaged by the heat of the sun scorching the leaves on the S. W. side of the hills, and killing the pollen of the blossoms, so that the silks could not be impregnated, rendering the grain abortive.

Autumn.—The mean temperature of autumn was 56°·50, which is nearly three and a half degrees higher than in 1853, and above the annual average. It arose from the heat of September 69°·96, which is nearly ten degrees above that of some years, and six above the mean for this month. The severe drought continued into the autumn, cutting off the fall crops of turnips, cabbage, &c. The yield of Indian corn was much lessened in amount, but bore the drought better than any other grain. It is the first year since the settlement of the state, which has threatened an entire failure of this staple crop. It is one, the loss of which, would be more injurious to the inhabitants than that of wheat; as it affords sustenance to both man and beast, and is the source from which that immense quantity of beef and bacon is supplied. It is supposed that the amount in the valley of the Ohio is fully one-third less than the average.

Floral Calendar.—February 8th, Robin seen; 10th, Bluebird; 12th, Honey bee abroad.

March 12th, Hepatica triloba in bloom; 15th, Early Hyacinth, Peach ready to open; 24th, Crown Imperial ready to bloom; 27th, Blackbird in flocks; 30th, Pyrus Japonica in bloom.

April 1st, Crown Imperial open; 2d, Hyacinth in full bloom; 4th, Martin seen, Primrose in bloom; 5th, Sanguinaria Canadensis; 6th, Spirea Prunifolia; 7th, Peach tree; 9th, Pear and Plum; 14th, Dodecatheon; 17th, Snow eight inches deep in the woodlands; 18th, Pear blossoms full of melted snow and frozen.

Thermometer at 26° and yet there was fruit; 21st, Apple tree in bloom; 24th, Chimney Swallow appears; 25th, Harebell; 29th, Four inches of snow fell; 30th, Lilac in bloom.

May 1st, Quinces and Cornus Florida; 3d, Papaw; 4th, Black Haw; 12th, Red Peoney; 13th, Yellow Rose; 16th, Weigelia rosea; 17th, Syringa fragrans; 21st Locust tree; 25th, Early strawberry ripe; 27th, Antwerp raspberry in bloom; 28th, Bulbous Iris; 30th, Syringa Philadelphica; 31st, Roses generally in bloom.

June 29th, Catalpa in bloom.

ART. XXV.—*On the Composition of Eggs in the animal series;* by A. VALENCIENNES and FRÉMY.—PART II.*

WE referred in our first article, to the observations made previously on birds' eggs. Taking these eggs for criterions, we exhibited the results of our researches on those of cartilaginous fishes of the family of Squalidæ (Sharks,) and of those of the Raiidæ (Rays). We remarked that the white shows hardly any traces of albumen, and that the yellow contains a substance insoluble in water, suspended in the liquid in small tables, of forms varying according to the species; we explained its characteristics and its composition, and we called it *Ichthin.* We continue the explanation of our researches on the eggs of animals, completing what we have to say of other kinds of fish.

Of the Eggs of the Osseous Fishes.

The larger number of osseous fishes are oviparous. The ovary and the oviduct are in one large common sac, rounded toward the top, narrowed toward the bottom, and enveloped in a fold of the peritoneum, which the anatomist can separate from the real membrane of the passage of the ovario-oviduct, these two oblong pockets are reunited a little before their exit, behind the rectum. Each organ is suspended above from the intestines by a ligamentary fold of the peritoneum. The lower portion of the abdominal region of this sac is smooth and without any fold of the membrane. On the upper or dorsal part, there are numerous scales, or lobes on which there are developed, in their own capsules, the thousands of ovulæ afterwards to be laid. These ovarian folds are divided and subdivided into secondary, tertiary, and quaternary lobes of forms differing with the species. They float in tufts and bunches, and in developing themselves, become those familiarly known masses of eggs. When the ovula is ripe, (to make use of the technical word,) it detaches itself from its ovarian capsule, it falls into the lower or oviduct portion of the sac,

* From the Journal de Pharmacie, &c., June, 1854, p. 415.

and after staying in this oviduct a long or a short time, it changes its nature there, and then it is laid in places along shores, sandy or rocky, in kinds of nest chosen or arranged by the instinctive faculties of the mother; after which it is hatched. As to the ovula or the egg changing the composition of its liquids during its stay in the oviduct:—this ovula while still shut up in its ovarian capsule, is more or less opaque, on account of the fat which it contains. Detached, it becomes transparent, the yolk surrounded by its albuminous matter is clearly visible, unless its vitellin membrane be of appreciable thickness, and the ichthulin of which we shall soon speak, is replaced by albumen. Thus the egg which shows only some traces of albumen when still attached to the ovary, becomes very albuminous when it is free in the oviduct. In the larger number of fish, the ovary is double. We have spoken of the prodigious number of eggs layed by some of them, and we could cite numerous examples. The number increases in proportion to the size of the females and the smallness of the eggs. As they are almost all of the same weight and size, we weigh the ovary and by counting the number of eggs in a gramme, we can estimate pretty closely, the entire number developed in the ovary. It is in the thick-lipped Grey Mullet (*Mugil Chelo*, Nob.) that we have found as yet the greatest quantity. One of this species of the length of $0^{m}\cdot60$, contained 13,000,000 eggs; a Codfish (Gadus Morrhua, *Lin.*) of one metre, gives 11,000,000; a Turbot (Pleuronectes maximus, *Lin.*) of $0^{m}\cdot50$ length, lays 9,000,000; we estimated 6,000,000 in a Plaice, (Pleuronectes maximus, *Lin.*) of the length of $0^{m}\cdot30$; the carp, whose eggs are the largest, gives only 600,000 or 700,000, when from $0^{m}\cdot15$ to $0^{m}\cdot50$ long. Other fish with only a single ovary, have a much smaller number of eggs, than those named. Having made an estimate on a dozen large perch of the rivers in Holland, Belgium, Picardy, and the neighborhoods of Paris, we found for a mean 71,000 eggs; Bloch gave nearly twice as many. We discovered in the eggs of the osseous fishes immediate principles entirely different from the ichthin of rays and sharks. The study of carps' eggs enabled us to appreciate these differences.

Carps' Eggs.—On studying under the microscope an ovula of a carp slightly advanced, it is seen that the liquid holds suspended in it a number of little drops of fat slightly colored, in the midst of which are to be seen swimming transparent granules, tabular in form, which recall those of the vitellus of the ray. The China *Dorado*, vulgarly the *Redfish*, (the Sea-bream, Cyprinus brama,) is another species of carp whose ovules present similar small grains mixed with drops of oil.

Ichthidine.—In spite of their resemblance in form, the granules of which we speak, are not formed of ichthin; for in treating the ovula crushed from a carp with a small quantity of water, the grains gradually decay and in a few minutes entirely disappear. The substance which constitutes them is then soluble in water, while ichthin is insoluble. Admitting, for a moment, that these grains are formed of ichthin, their solubility might be attributed to the action of the albuminous liquid existing in the carp's egg, which would thus show the property of dissolving the ichthin of Rays. To verify this hypothesis, we introduced some grains of ichthin from a ray into the liquid of the crushed eggs of a carp; the whole was submitted to the action of water. We then saw the granules of the carp's eggs gradually disappear; those of ichthin were not altered by the water. It thus seems to be demonstrated that there exists in the eggs of certain Cyprinidæ, a substance soluble in water, which presents itself in the form of rectangular grains. Although it has been impossible to give to this observation all the exactness desirable, for the soluble grains could not be isolated, yet we think we ought, while waiting for more satisfactory results, to give a name to this substance, and we propose that of *Ichthidine.* When we employed saline solvents, these grains always disappeared in the washings. Besides, the presence, in these eggs, of a body which we are about to describe, made this separation still more difficult.

Ichthulin.—We have just said that a small quantity of water mixed with the liquid obtained by crushing carps' eggs, in process of formation, made the rectangular grains of ichthidin disappear, and that it produced a transparent liquid, holding nothing suspended but a few grains of fat. By increasing the proportion of water, a new body immediately is seen in precipitate, which till then was in solution in the albuminous liquor, and which collected by being agitated, separates in the shape of a syrupy, ropy mass, insoluble in water. This substance is found in a large number of the eggs of birds which we have been in the habit of examining while they were in the state of ovulæ, retained in the ovary. We have established its presence in the Labrax lupus, the thick-lipped Grey Mullet (Mugil Chelo, *Nob.*), the Mackerel (Scomber Scombrus, *Lin.*), the Turbot (Pleuronectes maximus, *Lin.*), the common Sole (Pleuronectes Solea, *Lin.*), the Breton Sole (Solea armorica, *Val.*). We have established its existence, and in great abundance too, in the eggs of Salmon, already detached from the ovarian lobes, and fallen into the abdominal cavity. It seemed to us at least important to study it carefully, and to ascertain its composition. We have given it the name of *Ichthulin.* The liquid obtained by pressing the eggs of Salmon in a cloth is treated with distilled water, the albumen dissolves, and the precipitation of the ichthulin is effected. This substance is then purified by being washed with alcohol and ether.

At the moment of its precipitation the ichthulin is viscous and resembles gluten. But the action of the alcohol and ether causes it to lose its viscosity, and it becomes then solid and powdery. The ichthulin, which in its physical properties differs in every respect from ichthin, is very like it in its chemical characteristics. It is, like the latter, soluble in acetic and phosphoric acids; it dissolves too in hydrochloric acid, without producing a violet color. Its composition is as follows:

I.		II.	
Solid matter,	0·283	Solid matter,	0·253
Water,	0·205	Water,	0·190
Carbonic acid,	0·545	Carbonic acid,	0·495
Proportion of Azote.			
Solid matter,	0.338		
Azote,	0·05145		
Per centages.		*Per centages.*	
Carbon,	52·5	Carbon,	53·3
Hydrogen,	8·0	Hydrogen,	8·3
Azote,	15·2		
Phosphorus,	0·6		
Sulphur,	1·0		
Oxygen,	22·7		

From these analyses it follows that ichthulin differs in composition from ichthin: it approaches on the other hand that of albumen, and like it, contains sulphur and phosphorus. From these facts, it follows that the eggs of fishes of the family of Cyprinidæ, when only a little developed, contain, with a soluble substance ichthidin, a liquid strongly albuminous holding in solution mineral salts, some ichthulin, and suspended in it phosphoric fat. After obtaining these results, it seemed interesting to compare with eggs in the state of ovulæ the composition of eggs of the same sort completely formed, detached from the ovarian lobules and free in the oviduct. This examination has brought us to the establishment of this very important physiological fact: that is, that the composition of eggs undergoes, with the age of their development, important modifications, even before the laying, and during the time that they remain in the oviduct. It is in fact, a result of our analyses, that the eggs of the Carp, entirely formed, contain no longer traces of ichthidin; that the ichthidin gradually disappears, and that when they are become entirely transparent, these eggs are formed wholly of a liquor strongly albuminous, which holds suspended in it phosphuretted fat. The examination of Carps' eggs while young, has also shown us, that to study the eggs of these Cyprinidæ, it is necessary to guard against putting them in contact with water, which often dissolves bodies whose presence it is important to establish, and which in other cases, precipitates substances as the ichthulin, which were at first dissolved in it.

Perfect eggs (œufs mûrs) of the Mullet, Trout, Pike, Whiting, Plaice, Sole, and the Dab.—We have continued our former researches on the different fishes above named, taking care to profit by the season for spawning. We found in the ovary of the Plaice and Pike, and of the others, eggs entirely formed, not containing ichthidin at any period of their development, but very rich in ichthulin in their early age. Detached from the ovary, and free in the oviduct, they no longer showed us the least trace of ichthulin ; they then consist of a very albuminous liquid, containing a considerable quantity of phosphuretted fat. This quantity of albumen explains why the eggs of all these kinds of fish become hard by boiling.

Eggs of Salmon.—Salmon's eggs do not contain rectangular grains soluble in water. Those which we have examined were free in the abdominal cavity, they contained much of ichthulin and very little albumen. Their color, reddish yellow, is due to the presence of a considerable quantity of phosphuretted oil. Submitted to the process of boiling, they become opaque, but remain always soft, even if kept a long time in boiling water. This is easily understood, since they have only a very slight amount of albumen. Their opacity is caused by the water brought into them, which thus stops the precipitation of the ichthulin.

Eels' Eggs.—The eggs or rather the ovulæ of the eel, taken in fish kept in fish-ponds are much too small to enable us to make researches of any extent on these curious productions of the organs of generation. We have been able however, to assure ourselves that they contain perhaps still more fat than the eggs of Salmon, and they do not seem to have more albumen, for they do not harden by boiling. We have not been able to see in them the least trace of ichthidin. Our researches supply a very simple method of observing the eggs of the eel. It is sufficient to boil for a few minutes one of the ovarian lobules : then the eggs swell without hardening, the distended membranes become more apparent, and with sufficient enlargement, one easily sees the ovulæ which are hardly one or two hundredths of a millimeter. If, as we do not doubt, our further observations confirm those which we now publish, we will thus give an easy method, and a sure one too, to ascertain whether the female has kept its eggs long enough in its oviduct to perfect them, and whether they are in a condition to be productive. It will suffice to take a few from the body of the fish, to crush them on a glass-plate, and to add a little water. If there is no precipitate of ichthulin, the egg is perfect, for it only contains albumen and phosphuretted fat. If ichthulin is precipitated, it will be necessary to restore the fish to the water, and to wait awhile before proceeding to fecundation. We point this out as the most certain method, to persons who wish to try artificial breeding.

After having established that the eggs of fishes contain substances insoluble in water, ichthin and ichthulin, which have both of them, properties different from the vitellin of birds; we have inquired whether the albumen of fishes' eggs is the same as that of birds' eggs. Although we reserve the detailed account of this examination for a succeeding memoir, we are prepared to affirm that these two albuminous substances often present in their properties notable differences. In fact, the albumen of the eggs of certain fishes dissolves without any discoloration in hydrochloric acid, and it begins to coagulate at about 45°; while the albumen of birds' eggs, dissolves, as we know, in hydrochloric acid, and gives to the liquid, a violet-blue color, and it does not coagulate below 63°. Are these differences sufficient to admit really, in the animal organization several sorts of albumen? Can the blue color produced by hydrochloric acid, be considered as a specific characteristic of albumen? In short, may not the mineral salts contained in the albumen in different proportions, exercise an influence on the point of coagulation of this substance? These are delicate questions whose importance we appreciate, and which we shall treat in a special article to be devoted to albuminous substances.

(*To be concluded.*)

Art. XXVI.—*Chemical Examinations;* by Ezequiel Uricoechea, of Bogota.

1. *Chemical Examination of the Oloba, and of a new body, Olobile, contained in it.*

The Oloba, a fat, has been known in New Granada for a very long time, and I have no doubt that the aborigines were the first to use it, for we know well that they used the palm-wax for illumination, as Pedro Ciezor De Leon* tells us.

The tree which produces it is the Myristia Oloba† of about 20 meters height. It grows in the warm valleys of New Granada, and only there, for all the efforts to plant it in the table-land of Bogota, have been unsuccessful. Bonpland found the tree in Mariquita, west of the River Magdalena, a place well known for its silver mine.

The use of Oloba is to my knowledge, exclusively, in veterinary medicine, especially in the cure of skin complaints with horses, for although Garcia de Alonzo‡ made in 1808 some experiments with reference to using it for illumination, I believe nobody has followed them up.

* Cronica del Peru, Part I.
† Humboldt et Bonpland, Plantes Equinoxiales, tome ii, p. 8.
‡ Semanario de la Nueva Granada, (2d ed.) 1848. p. 341.

Playfair examined the well known Mochat butter, and discovered the myristic acid in it. It was very probable that in the butter obtained from another plant of the same genus the same constituents were to be found. Having received, however, some Oloba, direct from New Granada, I determined to examine it. When fresh, the Oloba exhales, on being melted, a very unpleasant odor owing to a volatile oil. The quantity that I received, however, had lost a good deal of this peculiar odor.

The Oloba was seen at once to be composed of different fats, a white one and a brownish-red, which although in close contact, irregularly disseminated through the mass, could easily be distinguished from one another.

To free it from impurities it was melted and filtered through a fine cloth, on which it left pieces of palm leaves, and a brownish-red mass (pollen?) which undoubtedly gave the coloring to certain portions of the Oloba. On cooling, the Oloba presented a crystalline texture and a yellowish-white color. Its melting point was 38°*. A determination of the melting point of the impure Mochat butter gave 51°, a difference from that of the Oloba which I cannot explain.

The Oloba, freed from all visible impurities by filtration, was boiled with a solution of caustic soda until every oily appearance had disappeared from the surface of the liquid. This was diluted with some water and common salt thrown in, in excess, so that after cooling, the soap, rendered insoluble, could be easily separated from the liquid. This was evaporated nearly to dryness and in the usual way the presence of glycerine proved, by its sweet taste and its acrol reaction. The soap was dissolved once more in water and decomposed by hydrochloric acid. The fat acids were melted again twice in boiling water to free them completely from the hydrochloric acid, and after cooling the second time, they were dissolved in alcohol.

A portion of acetate of magnesia equal to a twentieth part of the weight of the acids was taken, and after being dissolved in alcohol, mixed with the solution of the acids. By this process only a part of these acids could combine with the magnesia, those of course being the first to unite which have the strongest affinity. This is a very easy way of separating the fatty acids, and has been called "the method by fractional precipitation." After the first precipitation was completely separated, in this case always as crystals, it was filtered and into the filtrate another portion of acetate of magnesia in solution was thrown. This was repeated until the magnesia salt gave no precipitate even after standing for a long time in a cool place. Then acetate of lead was substituted; and when this, employed in excess, produced no more change, ammonia was added. In this way the different acids were sepa-

* The Centigrade scale is to be understood through this paper.

rated. I examined, however, only that one which was combined with the magnesia, the lead salt being left, for want of time, for a future examination.

The magnesia salt which fell from the alcoholic solution was decomposed by hydrochloric acid, and the fatty acid after being crystallized two or three times from its alcoholic solution had a constant melting point at 53°. Playfair gave as the melting point of myristic acid 49°, but Heintz in his masterly examination of the spermaceti* obtained for the melting point of this acid 53°·8, with which, my own observation, made before Heintz's article was published, agrees very well.

To be sure of the identity, an elementary analysis was made.

0·4275 gram. of substance gave 1·152 gr. of carbonic acid and 0·4750 gr. of water, or

	At.	Calculated.	Found.
Carbon, - - -	28	73·68	73·50
Hydrogen, - - -	28	12·28	12·34
Oxygen, - - -	4	14·04	14·16
		100·00	100·00

The analysis as we see, agrees exactly with the formula $C^{28}H^{28}O^{4}$ which Playfair gave for myristic acid, and which Heintz has recently confirmed.

In the first and sometimes in the second of the partial precipitations another substance is found which I have named Olobile (Oloba and ὕλη.)

It is less soluble in alcohol than myristic acid, but more readily so in ether; these particulars, and its crystallizing out first from a mixed solution are properties by which a separation from myristic acid is easily effected.

It crystallizes in beautiful (square?) prisms, colorless, transparent, and with a strong vitreous lustre. Melts at 133°; on cooling a few degrees, it solidifies to a crystalline mass; and on heating again the melting point remains the same. This reaction is so very different from that of Olivile, that it suggested at once the supposition that this was a new body.

Two elementary analysis were made in order to test this conclusion:

1. 0·2804 gr. of Olobile gave 0·7524 of carbonic acid and 0·1603 of water.

2. 0·1793 gr. of Olobile gave 0·4801 of carbonic acid and 0·1027 of water, or

	I.	II.
Carbon, - - -	73·19	72·86
Hydrogen, - - - -	6·35	6·46
Oxygen, - - - - -	20·46	20·68
	100·00	100·00

* Pogg. Ann., vol. xcii, p. 441.

Which leads us to the formula $C^{24}H^{13}O^{5}$;

		Calculated.	Mean of I. and II.
Carbon, - -	24	73,09	73·02
Hydrogen, - -	13	6·59	6·41
Oxygen, - -	5	20·30	20·57
		100·00	100·00

proving it to be a new body. For want of material, I have not studied the products of decomposition, which, no doubt, are analogous to those of Olivile, and no other reactions except its solubility in ether and alcohol, insolubility in water, melting point at 133°, and its non-volatilization were noticed. I hope after returning to Bogota, to study it further. Meanwhile this examination may do something towards giving a knowledge of a plant, so much used and apparently so beneficial at home. This first result obtained by me, is that Oloba contains a volatile oil, a fixed one, myristic acid in combination with glycerine, and Olobile.

2. *Analyses of two Gold Idols of the Aborigines of New Granada.*

My studies on the antiquities of my country, the result of which I have laid before the public,* gave me occasion to make analyses of the gold idols in my possession.

It is impossible to tell their age; yet it is certain they were made before the Spaniards conquered the country. The exact locality also is unknown, although they were sent to me from Bogota; but there is very little doubt that they were made by the Chibcha nation (called also Muiscas) and among them, the tribe which was known under the name of Guatavita, and whose inhabitants were renowned for working in gold.

We know of the lake Guatavita, that for ages, millions of gold idols were thrown into it as offerings to the gods in time of need. We also know that a powerful cacique every year entered the lake, bathed in turpentine and gold dust, and in the middle of it, after throwing in the largest amounts of gold, he himself followed the gold into the waters where they had disappeared, and bathed; which story gave the name "El dorado" to our country. The Indians of this nation then, were the gold sculptors, and the alloy they mixed was the one I examined.

The external color of the metal of these idols is different; some are light yellow and others copper-red. On heating the alloy it blackens at a red heat, becoming covered with the black oxyd of copper. On washing it with hydrochloric acid, the color becomes yellowish white, probably by the formation of chlorid of silver; for by washing it again with ammonia it becomes copper-red.

* Memoria sobre las Antiguedades Neo-granadinas. Berlin, F. Schreiber & Co., 1854.

The analysis of such an alloy is so simple that I need only give the results.

	I.	II.
Gold, - - - - -	54·63	45·91
Silver, - - - - -	16·31	10·55
Copper, - - - - -	29·31	43·70
	100·25	100·16

All the analyses that we possess of native gold from New Granada* give no copper; which makes us at once suppose that the aborigines knew the art of alloying, for they could find copper in the native state in several parts of New Granada as for examples in Moniguirà.

It is difficult to say how they could use coins without any stamp, merely round plates of gold, while they know how to alloy metals, for undoubtedly great frauds could be made. Acosta however, is of opinion that the Chibchas had the gold plates for currency and were the only American aborigines that made use of the metal, as coin, in their exchanges.

Art. XXVII.—*Review of the Fifth volume of the Agriculture of New York, &c., by E. Emmons.*†

'Ignorance *per se* is not a crime, its heinousness depends upon the use which is made of it.'—*American Journ. Sci. and Arts.*

This volume purports to contain descriptions of the more common and injurious species of insects found in "New York and New England." It contains 256 pages of text, and 50 plates, 47 of which are colored.

The text, as is intimated in the preface, has been mostly collected from the researches of others, and in truth, in the descriptive portion of the work, brief specific phrases alternate with excerpts from the synopsis of British genera at the end of Westwood's Introduction to the modern classification of insects.

However applicable these diagnoses may be in British Entomology, it may be doubted whether they can be used with advantage in a country where a large number even of common insects belong to genera not found in Britain, or whether it was necessary to copy from foreign works, when there are men of ability in the land who could have given original and accurate descriptions. We feel assured that a small compensation compared with

* Dana's Mineralogy, and Coleccion de Memorias cientificas por Joaquin Acosta. Paris, 1848. p. 43–50.

† Natural History of New York: *Agriculture of New York*, comprising an account of the classification, composition, and distribution of the Soils and Rocks and of the climate and agricultural productions of the State, together with descriptions of the more common and injurious insects; by E. Emmons, M.D. Vol. V. Albany, 1854. The volume is devoted to the last topic, "The Insects of New York."

the money which has been expended on the volume before us, could have secured an original memoir, that would have been useful both to the scientific student and to those seeking for information in a popular form.*

The plates contain figures of many of our common insects of each order. The figures are in general recognizable, but the execution is disgraceful. The references are frequently confused and more often imperfect, even for the most common species.

As the plates appear to be the most important part of the book, and a review of the whole would be tedious, we will begin by mentioning some of the important errors conveyed by the figures of Coleoptera. To go through the other orders would require more patience than can be properly claimed either of our readers or of ourselves; moreover, as the order of Coleoptera has been better studied than any other, and information regarding it is more accessible to both the student and the compiler, a glance at the part of the work devoted to it will probably enable us fairly to appreciate the method pursued by the author.

Pl. 2, fig. 8, '*Clerus apiarius*.' The name belongs to a European insect; the figure if not copied from a European work, may represent our somewhat allied Trichodes apivorus *Germ.*

Pl. 5, fig. 2, '*Buprestis dentipes*' is B. punctulata *Sch.* (transversa *Say*), and belongs to the genus *Dicerca*; B. dentipes *Germ.* is a *Chrysobothris*. Fig. 8, '*Buprestis* ——' is an Elateride, not noticed in the text. Fig. 10, '*Dyticus Harrisii*' is D. verticalis *Say*.

Pl. 8. The very abundant *Clytus colonus* is queried; while *C. erythrocephalus* is left unnamed: fig. 4, of the reference is marked 5 on the plate, while 4 is omitted: we thus have 13 references to 12 figures. Fig. 9, '*Elaphidion*' is irrecognizable.

Pl. 10, fig. 5, '*Scarites* ——' is the very common *Passalus interruptus*, and is noted among the corrections (p. 256) as "allied to Sinodendron," but its name is not given.

Pl. 11, fig. 3, '*Coccinella* 12-*notata*' is Hippodamia convergens *Guérin*. Fig. 11, '*C. binoculata*' is (text, p. 137) described as C. trioculata: the description of *C. binotata*, p. 138, we may remark in passing, is altogether wrong.

Pl. 12, figs. 10 and 11, '*Platycerus piceus*' in recent times is placed in the genus *Ceruchus*.

Pl. 14, fig. 5, '*Chrysomela tremula*.' Why is this European species introduced into the Natural History of New York? It has been frequently figured in its own country.

Pl. 14, fig. 4, '*Galleruca* ——' is the well known Galleruca (Diabrotica) 12-punctata: in the text, p. 129, it is noted as Crioceris

* Even a few plates added to Dr. Harris's admirable treatise On the Insects of Massachusetts injurious to Vegetation, would have given to the farmer, as well as to the scientific observer all the necessary information regarding our injurious species.

12-punctata, and on p. 134, reappears as '*Adimonia* ——'. Immediately following the description p. 134, is placed *Lema trivittata*, thus putting it in a group to which it does not belong. Per contra, the same insect appears on page 129, as 'Crioceris (or Lema) trilineata (Oliv.).

Pl. 17, fig. 6, '*Cicindela campestris*' is C. 6-guttata; we are at a loss to understand the motive for introducing the European C. campestris in a Zoology so well provided with species of the genus. If another figure was wanted to fill up the plate, there are several American species well worthy of the place.

Pl. 17, fig. 14, '*Cicindela* ——,' is the well known C. unipunctata, but probably, to quote the words of a former collaborator on the Survey, is 'extra-limital.'

Pl. 17, fig. 15, '*Cicindela? (Maryland)*,' is Megacephala virginica, and is so noted in the corrections on page 257, with many others not introduced in this review.

Pl. 19, fig. 9, '*Anisodactylus agricollis*' (!!)

Pl. 20, fig. 8, '*Chlænius lithophilus*.' Particularly bad, if it be the species intended.

Pl. 20, fig. 11, '*Omophron labratum*' is O. americanum *Dej.*, and fig. 12, 'var. tesselatum', is nothing like O. tesselatum *Say*. The forms are strangely caricatured.

Pl. 21, fig. 4 '*Lampyris ungulata*' should be L. angulata, and fig. 5, '*L. scintillaris*' ought to be L. scintillans: neither fig. 7 or 8 belong to Dictyoptera, but if not placed in Digrapha, they should have been left where they were found, in Lycus.

Pl. 21, fig. 9, '*Dicælus dilatatus*,' and fig. 13, '*D. elongatus*.' These have been reversed in some way: the references in the text (p. 49) are right. Fig. 10 is anything rather than Sphœroderus stenostomus.

Pl. 23, in two places we find *Necrophagus* for Necrophorus.

Pl. 25, fig. 3, '*Platycerus piceus*;' for another insect under the same name, vide pl. 12; fig. 5, '*Osmoderma scaber*' seems intended for O. eremicola; fig. 6, '*Pyrochroa flabellata*' is very bad, while fig. 8, '*Upis pennsylvanicus*,' represents nothing found in the country.

Pl. 31, fig. 1, '*Cantharis atrata*' is a duplicate of pl. 25, fig. 4. Each figure appears to be worse than the other, but the strongest impression is left by the one last looked at. Can fig. 4 be '*Onthophagus Hecate*'? Fig. 8, '*Hister conformis*' is H. abbreviatus *Fabr.* '*H. conformis Dej.*,' belongs to the genus Saprinus, and was described and figured in the Boston Journal of Natural History, so that no excuse can be offered for the confusion. Fig. 10, not '*Tenebrio molitor*,' but a species of Iphthinus; fig. 13, '*Copris* ——' is C. anaglyptica *Say*.

Pl. 34, fig. 1, '*Podabrus modestus*' is Telephorus carolinus. What can fig. 2 be? It is marked '*Stenocorus cinctus*,' but the resemblance is not apparent. Fig. 3, '*Telephorus* ——' is Nacerdes melanura, an Œdemerite described by Linnæus, found in all our cities, and now carried by commerce from Europe over the greater part of the globe. Fig. 7, '*Saperda* ——' we have already had on pl. 16, as S. calcarata. Fig. 8, '*Monohammus pusillus*' is Graphisurus fasciatus. Fig. 9, '*Cerambyx* (undescribed)' is Dorcaschema nigrum, long ago described by Say. Fig. 11, '*Leptura* ——' is Toxotus cylindricollis *Say*, also a well known species.

Having thus mentioned some of the more conspicuous errors in the plates, and referring for others to the list on page 257 of the text, we may now turn our attention to that portion of the work.

It is, as was stated before, mostly made up of extracts from other works; with what skill these are placed together will appear shortly. In the mean time we regret to be compelled to call attention to the fact, that while on page 25, it is stated that the anatomical figures have been copied mostly from the Naturalists' Library, we find the plates (A, B and C), on which these figures appear, credited to E. Emmons, Jr. Could not the lithographer be trusted to make the copies? Why should the expense of repeating the drawings be thrown on the State? That under a liberal grant from the Legislature, such as has been expended in the New York Survey, our entomology should be illustrated by copies of foreign figures of foreign species is at least discreditable; but what can be said, when an author permits a person in his employment, to affix his name to these foreign labors?

Continuing our exposition of errors, we find that on page 31, the reader would be inclined to believe that Mr. McLeay has divided all *beetles* into 1, Geodephaga and 2, Hydradephaga: this is not so.

Page 35, for '*Cicindela guttata*' read C. sexguttata.

Page 39, Div. 5 of Carabidæ, '*Bembidiides*' are placed under those having the 'anterior tibiæ without a notch near the tip': on page 53, a contrary statement is made, that 'the anterior tibiæ are always notched on their insides near their tips.'

Page 41, the explosive power characteristic of Brachinus and closely allied genera, is here extended to the whole section of Brachinides as defined by Westwood.

Page 42, '*Polystichus* (Bar.)' is placed as a synonym of Galerita, and the description of the former copied from Westwood. Polystichus was never applied to North American species, but was established by Bonelli (not Bar.) upon certain small European insects, previously placed in Galerita.

The system of arrangement pursued by the author, will be better illustrated by an example, than by any criticism. Commencing therefore with the genera of Harpalides (p. 45), the succession is : Agonum, Harpalus, Pangus, Amara, Agonoderus, Anisodactylus, Chlænius, Trechus, Calathus, Anchomenus, Dicælus, Sphæroderus. Then comes the family Carabides with Cychrus, &c.

Many of the genera are not described; when descriptions are given they are, as frequently as possible, taken from Westwood's synopsis above mentioned : this however can be done only with genera found in Britain ; for the rest we have sometimes, as in Galerita, a misapplication of a description of an allied genus, or occasionally an original description ; as a specimen of the latter, we will take Agonoderus (p. 47). "Head subquadrate, thorax subquadrate, slightly narrowed behind, elongate: the thorax equals in width the base of the elytra.

Page 55, we have 'Dyticus' ranked under Haliplides.

Page 60, '*Dermestes lardarius*' is placed in the family Cucuiides.

Page 61. The generic description of *Staphylinus* fails in two of the three species placed under it : the one to which it applies, S. cyanipennis, is not a Staphylinus, but a *Philonthus*.

The names of authors are usually omitted, references to their works under synonyms or names are never given. Where the authorities are mentioned, '*Anchomenus extensicollis* (Steph.)' and '*Necrophorus pygmeus* (Rich.), show what reliance may be placed on them.

The genera of Lamellicornes have been arranged on the same principles as the Harpalides already cited. The succession (p. 67) is; Geotrupidæ, Geotrupes, Coprobius; Scarabæides, Onthophagus, Phanæus, Aphodius, (with a remark on Lethrus cephalotes,) Copris. The parallelism of the results is further illustrated by the description of Coprobius, which being an American genus is not found in Westwood. "Body ovoid ; thorax dilated in the middle, scutellum none : abdomen nearly square, clypeus bidenticulated ;" this will compare favorably with Agonoderus above.

But it is time to stop. Although we have gone over but a very small portion of the volume, our readers have had enough to enable them to judge of the character of the work. The task of the reviewer is a thankless one ; but if it will prevent books of like merit or rather demerit from appearing in future 'by authority,' it has not been performed in vain. Indignant protests from students of Entomology, should at once dispel the illusion, if such there be, that this volume is an exposition of the present condition of their science in this country. J. L. L.

ART. XXVIII.—*Caricography*; by Prof. C. DEWEY.

(Continued from vol. xviii, p. 104, Second Series.)

No. 246. *Carex lucorum*, Willd., Kunze Suppl., No. 47, fig. 39, non Sart., Car. Am. Sept. Exsicc. no.

Spica staminifera unica; spicis pistilliferis 2–3, subglobosis, sessilibus, bracteatis; fructibus *tristigmaticis*, ovatis vel subglobosis, subtriquetris, pedicellatis, hirtulis, nervosis, prolongo-rostratis, bidentatis, squama ovata oblonga acuta sublongioribus.

Culm triquetrous, slender, erect and subscabrous on the angles; leaves narrow linear, scabrous on the edge; fertile spikes two or three and sessile, ovate and few-flowered; stigmas three, and very long; fruit oviform, tapering below or stipitate, rostrate above, two-toothed; the beak large and about half the length of the whole fruit, and deep-split; pistillate scale ovate, oblong and acute or ovate-lanceolate, a little shorter than the fruit.

Kunze remarks the resemblance of this species to *C. Pennsylvanica*, Lam., and to *C. marginata*, Schk. It has the same reddish scales, but is easily distinguished by the peculiar shape of the fruit and the beak.

As this species is very distinct, and should be recognized by our botanists, I have derived the preceding description from Kunze for their benefit. The plant has probably been confounded with *C. emarginata*, Schk. Kunze states that it was raised from American seed in the Botanic Garden at Berlin, and afterwards the plant also was received from a collection made by Rugel at Bergen on Broad River, North Carolina, May, 1841.

Though I labelled some specimens, a few years since, by this name, I am not confident of their identity with this species of Willdenow. The fruit of *C. nigromaginata*, Schw., is too unlike that of this species as given by Kunze.

NOTE.—*C. marginata*, Muhl. and Schk., has been considered to be *C. Pennsylvanica*, Lam. The former was described in vol. xi, p. 163, First Series, and the latter referred to it. A more extensive comparison of specimens over our wide country from New England to Kansas Ter., has led me to conclude there are two species under these two names, manifestly distinct. As the one has been described, as above, the other is here given.

No. 247. *C. Pennsylvanica*, Lam. Encycl.

Spica staminifera unica cum squamis oblongis obtusis; pistilliferis 2–3, ovatis, sessilibus, inferiore bracteata, fructibus *tristigmaticis*, oblongo-ovalibus vel ovato-oblongis, trinervosis, subtriquetris, brevi-rostratis et bidentatis, tomentosis, squamam ovatam subacutam subæquantibus.

Common over the United States, and the plant usually designated by this name, with which *C. marginata*, Muhl. and Schk., has been confounded.

C. marginata, named and described by Muhl. in his Gram., and sent by him to Schk., who described and figured it in his Reidg., Part 2, p. 49, fig. 143, is a short plant, 4–8 inches high, (a span high, Muhl.) stocky, with leaves erect and longer than the culm even before the fruit matures; spikes few-fruited and sessile, with fruit distinctly *globose* and short rostrate and sub-stiped; while *C. Pennsylvanica* is about twice as tall, 8–15 inches, slender, with short leaves till late in the season; spikes with more fruit, and the fruit oblong or long-oval, plainly triquetrous.

Both appear easily distinguishable from C. varia, and other species of the same family.

No. 248. *C. Persoonii*, Sieb. Herb., H. Aust., No. 282, secundum Lang in Linnæa, vol. viii, p. 539.
— *vitilis*, Fries, Nov. Mant., iii, p. 137 et Summa Veg. Scand., p. 223.
— *canescens*, L., var. *alpicola*, Wahl.
— *canescens*, L., var. *brunnescens*, Koch.
— - - - var. *sphærostachya*, Tuck. Enum.
— *sphærostachya*, Dew., Sill. Journ., vol. xlix, p. 44, Ser. prima.
— *gracilis?* Schk., Part 1, p. 48.

Spiculis 3–5, ovatis, approximatis in apicem vel infra subremotis, alternis, sessilibus, paucifloris, bracteatis, inferne staminiferis; fructibus *distigmaticis*, ovatis, submarginatis, substriatis, oblongo-lanceolatis vel tereto-rostratis, convexo-planis, glabris cum rostro sæpe dorsum fisso, squama ovata hyalina longioribus; culmis subprostratis, *vitiliusculis;* foliis planis margine scabris.

This more full description of this species than in vol. xlix, p. 44, is here given from a more full examination of the plant with the descriptions of Fries and Lang. The synonyms show the attention to this plant in Europe and in this country. Being unacquainted with the older descriptions of Sieb. and Fries, I had made it a distinct species, as above mentioned.

In his description, Fries states distinctly the difference of C. vitilis and C. Persoonii, and yet in his tabular view, Sum. Veg., p. 72, he denies the true specific difference, and inquires whether they are not the same. But Dr. O. F. Lang, in the Linnæa, edited by D. F. L. von Schlechtendal, Professor and Director of the Botanic Garden at Halle, has proved the identity of these two species. Indeed, the descriptions of Fries and Lang so nearly coincide as to exclude doubt. The chief difference between them is the *split on the back of the beak*, which in the abundant specimens of our country is a character *often*, not always, clearly present.

C. Persoonii, Sieb., is the proper name due to the plant.

This species is wholly different from *C. disperma*, Dew., for which C. vitilis, has been substituted by Dr. Boott. But this has stamens *below*, and C. disperma *above;* and the fruit and scale of the latter are very diverse from those of the former. In our country, *C. Persoonii*, Sieb. the *C. vitilis*, Fries, can not be confounded with *C. disperma*, Dew. The above characters show that this substitution can not be sustained. The somewhat *vine-like* form of C. Persoonii, for which it was called C. vitilis by Fries, is directly opposed to such confounding of names.

It is to be noticed also, that *C. disperma* is not confounded with *C. gracilis*, Ehrh. by Dr. Boott, or with the very different *C. gracilis*, Schk., Part First, p. 48, fig. 24, which is described by Schk. with stamens *below*, and *not above*, and which is probably a minor form of *C. sphærostachya*, the *C. Persoonii*, Sieb. given above; see the remarks on that species, vol. xlviii, p. 44, in this Journal.

No. 249. *C. tenax*, Chapman in MS. Boott, Richardsoni Arct. Exped.

C. Chapmani, Sartewellii, Am. Sept. Exsic.

Spica staminifera unica brevi; spicis pistilliferis 2–3, ovatis vel brevi-cylindraceis, densi-fructiferis, inferiore subpedicellata; fructibus *tristigmaticis* variis infra subteretibus, longo-conicis, vel brevioribus et bidentatis, multinervo-striatis tomentosis, squama ovata acuta duplo longioribus.

Culm a foot high, erect, with leaves short and flat; staminate spike short, with oblong and acutish scales; pistillate spikes usually three, lowest pedunculate, ovate or short, cylindric, close-fruited; stigmas three; fruit some tapering downwards, ventricose in middle, long or short conic and often bidentate, villose, many nerved or striate; pistillate scale ovate, acute or mucronate, half the length of the fruit.

Florida; Dr. Chapman, who long since distinguished it from C. dasycarpa Muhl. and gave it the above name.

From C. dasycarpa, whose fruit is ovate, clearly triquetrous, rather obtuse, scarcely nerved or striate, it is easily separated.

Note.—The following views of the synonymy of the species to be mentioned, are presented, in the hope of throwing some light upon a difficulty long felt in our country.

C. loliacea, L. et Wahl.

C. gracilis, Ehrh., Lang in Linnæa, vol. viii, p. 542, No. 56. Sill. Journ., vol. xi, p. 306, Serie prima.

Culmo tenui gracili scabriusculo, foliis planis margine subscabriusculis; spica composita, spiculis 3–4 rotundis paucifloris gynæcandris (infra staminiferis) remotis; fructibus oblongo-ellipticis nervosis obtuse erostratis, ore integerrimo. Lang ut supra.

This description is given from Dr. Lang, a laborious and discriminating Caricographist, because it was made after extensive examinations so late as 1847, and published after his death in the Linnæa by Dr. von Schlechtendal for its singular merits in 1852. On examining recent specimens from Lapland, I find little to change in the description of C. loliacea in vol. xi. The scale of the fruit is not "*acute*" but subacute, and the fruit is *very obtuse.* In the words of Dr. Lang, "Fructus ita obtusi ut apice fere rotundati sunt," evidently following Wahlenberg's description as quoted by Prof. Gray in vol. iv, p. 21, of this Journal, 2nd Series.

The synonymy of *C. gracilis*, Ehrh., has been made difficult by the manner in which the synonyms were left by Schk. in the two Parts on Carices. Prof. Gray gave a plausible solution in the reference just made to vol. iv. To learn if any new light had appeared, I wrote to Dr. von Schlechtendal, Professor in the University of Halle, by which Schkuhr's collection of Carices is possessed, for information. This was immediately given, and the letter shows that *C. gracilis*, Ehrh. is considered to be, and actually is, the true *C. loliacea*, Lin. After stating that Ehrhart published no characters or descriptions of his XII decades of dried specimens, but merely attached to each plant a schedule or label containing the *number*, the *name* and the *author*, and the *locality*, he adds the following:

"In the collection of Carices of Schkuhr himself, which our University possesses, under the name of C. gracilis is present a single specimen of that collection of Ehrhart on whose label is read, '78, *Carex gracilis*, Ehrh., Upsaliæ.'

"Hence there is no doubt, but that Ehrh.'s plant is the same with that of Schk., nor can there be a doubt, that this *C. gracilis*, Ehrh. (of which I possess two original specimens in my own herbarium, marked with the same Ehrhartian label) is clearly the same with *C. loliacea*, Lin, as Schk. has himself already said, and all the more recent botanists agree; and indeed as I maintain from comparison of specimens from Sweden, Norway, and Russia with those of Ehrhart."

As *C. gracilis*, Ehrh. was placed by Schk. with his C. loliacea, it is evident that Schk. considered the plant as the *C. loliacea* L., and of Wahl., for he uses the description of both on *C. loliacea*, L., in his Part Second, No. 47, p. 18; and, having done this, the wonder is, that Schk. should also have quoted *his* C. gracilis, Part First, p. 48 and fig. 24, as a synonym, when the description and figure prove the plant so utterly different from *C. loliacea*, L., in nearly every particular. By the letter of Dr. Schlechtendal, doubt is removed, and the synonymy made certain.

Still further: *C. tenella*, Schk., Part First, p. 23, and fig. 104, is also given by Schk., Part Second, p. 19, as a synonym of *C. loliacea* L. This is another great mistake, but is corrected by the later authors. Thus, *C. tenella*, Schk. is described by Fries in his Sum. Veg. Scand., p. 224, with a direct reference to the same figure, 104 Schk., and fully distinguished from *C. loliacea*, L. The spikelets of C. tenella have stamens at their summit, while the other has them at the base. By Dr. Lang in the Linnæa, vol. viii, p. 518, C. tenella is described under the name of *C. Blyttii*, Nyland, and the same fig. 104, Schk., quoted. Lang remarks that this species "was formerly, and still is confounded with *C. loliacea*, L.," but is *distinguished "toto cœlo" by the position of the stamens from C. loliacea.*

Hence it is evident, that *C. gracilis*, Ehrh., *is not C. tenella*, Schk., Part First, p. 23.

The only remaining difficulty in the synonymy is whether *C. disperma*, Dew. is the same as *C. tenella*, Schk. The separation of *C. gracilis*, Ehrh. from *C. tenella*, Schk., does not of course decide the other case either way. Mr. Tuckerman in his Enum., p. 19, says, "Haud tamen licet, etiam si certum plantam nostram Schkuhrii C. tenellam esse, nomen Deweyi mutare, quia auctor ipse C. tenellæ nomen suum aboluit." But the name, C. tenella, is perpetuated by later writers. Let, then, *C. disperma*, Dew., be absorbed in *C. tenella*, Schk., when their identity is established. This may be accomplished or not ere long by comparison of specimens at home and abroad. In the mean time the following points deserve attention. In Sum. Veg. Scand., Fries states that *C. tenella is taken by many for C. loliacea*, but this mistake can not be made in our country when the specimens are mature, if at all, where C. disperma is compared. Fries indeed says, that *C. loliacea, more slender, more humble*, and *commonly with two fruit, is with difficulty to be distinguished from C. disperma*, Dewey! showing that he had seen C. disperma and judged it to be nearer to C. loliacea than C. tenella is, and of course different from C. tenella. Yet C. disperma differs from C. loliacea "toto cœlo" by the position of the stamens, and when the stamens are visible can not be mistaken for *C. loliacea*, L. Neither can their fruit be confounded.

Fries also gives the following characters of C. tenella, viz., "fructibus *ovalibus* obtusis *erostratis* obsolete nervosis, squama *ovato-lanceolata* acuta triplo longioribus," several of which are not found in C. disperma.

From these considerations, the following synonymy are my results:

1. *C. loliacea*, L. et Wahl., Schk., Pars 2, p. 18, excl. synonymis.
   C. gracilis, Ehrh., non C. tenella, Schk.
   C. loliacea, Fries et Lang.

2. *C. tenella*, Schk. Pars 1, p. 23, fig. 104, non Pars 2, p. 18.
   Fries, Nov. Mart. iii, et Sum. Veg. Scand.
   C. Blythii, Nyland, et Lang in Linnæa.

ART. XXIX.—*On a remarkable change which has taken place in the composition and characters of the Water, supplied to the City of Boston, from Lake Cochituate;* by AUGUSTUS A. HAYES, M.D., Assayer to State of Massachusetts.

(Read at a meeting of the American Academy, 11th January, 1855.)

IN the study of the chemical composition of waters, used for domestic purposes, a wide field is opened for inquiries of high scientific interest, as the accurate comparisons of different waters, lead us through both departments of modern chemistry, the organic and inorganic. This interest is however secondary to the importance of careful inquiries in an economical view, as we have actions of waters on substances with which they come in contact, at one point modifying their composition so as to render them purer or less salubrious, and when a water passes some distance, its characters may thus be made to differ at different points. Not only is the water changed by contact with different bodies, with which it is brought in contact, but conduits of masonry or iron are in special cases rapidly destroyed.

Although my observations on the water supplied to this city were among the earliest made before its introduction, they have been continued since that time, and within two years partial analyses have been made almost weekly, for the purpose of learning the cause of any changes occurring. The results thus obtained will be given in a future paper, with the conclusions arrived at, in a general form—while at present, it is my design to call attention to the condition of the water, as it has existed for about ten weeks.

Cochituate water, derived mostly from surface drainage, as it is found in the Pond or Lake, belongs to the class of peaty waters, so common in New England. It has not characters in common with the green or colorless waters of limestone formations, nor the medium or mixed qualities of our river waters. In its normal state, it may be considered as a pure water, holding in solution four or five grains of mineral salts in one U. S. standard gallon, and these consist of compounds of chlorine with sodium, potassium, calcium, and magnesium, carbonates and silicates of these bases, in varying proportions at different seasons. Its organic constituents, including the gases dissolved, are those of the most importance, as they give it particular characters, modifying its chemical relations and affecting the taste, color, and purity of the fluid.

In the spring and autumnal seasons, there are found ulmic, crenic and apocrenic, and humic acids, with sparingly soluble compounds of these acids and bases, including alumina and oxyd of iron. With them there is a neutral body, which resembles mucilage from gum, and is usually in a changing state, especially while the water is warm, in the summer season. The gases dissolved are oxygen, nitrogen, and carbonic acid : the nitrogen never has the volume relation to the oxygen which exists in the air, being, except in rare instances, in smaller proportion, and cases have occurred, when the nitrogen was no more than 20 volumes to the oxygen 80. The volume of carbonic acid also varies, while about one volume of all the gases exists in thirty-six of normal water. There are present, also numerous animalcules and infusoria, fresh-water sponges and abundance of ochry matter, resulting from the chemical action of the water on the iron pipes. The animalcules indicate a state, which really exists,—of a disturbed balance between the fish, crustaceans, animalcules, and sub-aqueous vegetation of the lake. Although throughout the year, the water, at times increased by rains and melting snow, cannot be classed with putrid waters, there are periods in every season, during which it closely approaches to these in character.

In the latter part of October last, I was watching, for the increased amount of organic acids, due to the decomposition of vegetable matter, after a season of drought, succeeded by copious rains, when I was greatly surprised to find the humates and apocrenates giving place to crenic acid and crenates, accompanied by a perceptible odor of decomposing vegeto-animal matter, such as is emitted by freshly disturbed soil. This odor, which characterizes the humus from animal matter, continued several days, the water became colorless, while the organic matter, including carbonic acid, increased so as to exceed nineteen times the minimum amount previously found. The condensed vapor from the water had a strong odor of earth, or precisely that of guano from humid climates, and possessed an acrid reaction. No more than a mere trace of ammonia could be thus detected. When the water was mixed with lime and distilled, the condensed vapor was ammoniacal, proving that no carbonate of ammonia from the soil was present, but a *salt* of ammonia due to decomposition. The earthy odor, or (so called) taste, was succeeded by one closely resembling that of fresh-water fish, which, with slight variations in intensity, has continued nearly ten weeks. Before the water throughout the city became thus contaminated, the suggestion arose that the cause was local ; the secondary main supplying my dwelling-house having perhaps retained some parts of eels or fish. A careful examination was made and by analysis, a portion of *oil* was separated from the water, which had been filtered through muslin to remove suspended impurities.

By distillation, the odor could be isolated from the water, which thus lost, what was pronounced by good judges, to be the taste of fish oil, while the water, retained the oil, almost destitute of odor.

The general supply of water to a populous city, had thus become very offensive, without any adequate cause appearing, and the evil led to the expression of many hypotheses and suppositions, chiefly without reliable support.

As the subject was one within the reach of experiment, the course adopted was the following: A displacement apparatus of glass, was charged with recently calcined animal charcoal, of medium fineness; over this was placed a conical filter of clean cotton, so that any water, falling on the charcoal, would first pass through the cotton filter. The water from a contracted supply pipe, was allowed to flow slowly on the cotton filter, and passed away, so long as the pores remained open. Removing the cotton filter, the charcoal was allowed to drain, the water displaced by alcohol, and the alcohol by sulphuric ether, without removing the coal. Some oil was found in the alcoholic fluid, while the aqueous ether was colored by it, from a tint of yellow to a light olive color.

By evaporation at 90° to 100°, the ether left some globules of fluid oil, but by far the larger bulk of residue, was a soft solid in granules, without crystalline form. By warming the solid with a little acid, a base was dissolved, generally lime, or lime and ammonia, while the oil floated on the fluid, and was left by evaporation of the water. As thus obtained, this oil was of a light yellow color, presenting both oleic and stearic acids. Its specific gravity was the same as that of lard oil. Alcohol dissolved it without residue. A solution of carbonate of soda saponified it when warmed, proving the acid condition of the oil. With sulphuric acid it blackened, and chlorine changed its color to dark brown.

The oil, as separated from the etherial solution, in different experiments, assumed a solid state at 80° or 90° F. Acids eliminated oily fluids constantly, with the emission of a peculiar odor. Treated with carbonate of soda, when the soap was decomposed, an odor resembling that from adipocere was generally perceptible. When the charcoal, while wet from the water, was distilled, the vapor, which was first condensed, had a strong fish-like odor. It would putrefy and run through the changes resulting from the production of Conferva.

The mass of the water supply, was constantly changing from its state of approach to putrefactive fermentation—in which free crenic acid and crenates appeared, with a large volume of carbonic acid—to its more nearly normal state. At one time, twenty-eight volumes of water evolved, by boiling, one volume of gases. Twenty-five volumes of the gases were diminished only one volume, by phosphorus, warmed and left twenty-four hours; or about four per cent. of oxygen, seventy of carbonic acid, and twenty-six of nitrogen. Such a gaseous atmosphere dissolved in water, could not support animal life, in the higher forms of organization. As the oxygen gas increased in volume, the apocrenates and humates appeared, and the water which had no action on iron, assumed its ordinary action on this metal. The crustaceans increased in quantity and size, the Cyclops and Daphnia became predominant, and the cotton filters were soon closed by their bodies. Attention was now given to the mass collected on the filter, as had already been done with the sponges, and some vegetable organisms, including Conferva.

The fish-like odor was mostly retained by the filter, which had not been the case in the earlier experiments, and it became easy to separate from the gelatinous mass on the cotton, the oil, with the odor, or apart from it. As separated from the mass, the oil possessed a fugitive green color, at times, but the dried filters extracted by ether, afforded a yellow oil. The variations in color were found to be due to the state of the matter on the filter, which, evidently of animal origin, decayed rapidly, and the oil and odor became merged in a body, much like adipocere. The water, which had been purified by means of animal charcoal, was free from taste and odor; its vapor did not possess odor, and the larger part of the organic matter had disappeared.

As the chief contaminating matter in this water was arrested from a current by even a coarse filter, and the experiments had been repeated so frequently as to leave little else for chemical trials, I placed in the hands of Dr. John Bacon, for microscopical examination, the substance, like that, from which the odorous oil had been taken.

Dr. Bacon at once detected the source of the oil, the bodies of the Cyclops and Daphnia, being in large part filled with it,*—ten or fifteen globules, of different sizes, could be seen in a single subject,—but the most remarkable fact in this connection is the varied color of the oil. Under the microscope while many subjects presented a yellowish-brown oil, some were filled with colorless oil, and not a few had oil of a blackish blue, shading to indigo blue.

This fact explains the production of green and olive green etherial solutions, and it was found that the decomposing remains, were often red and yellowish brown—and in that case afforded light yellow solutions. No other substance, but those named, was found among numerous collections, which could afford oil; the connection between the chemical proofs, and microscopical observations was most skillfully made by Dr. Bacon, in the way of extracting the oil, while the subject was in the field of the instrument.

At this point of the research, a series of experiments was undertaken, which demonstrated that the fluid oil first obtained by animal charcoal, was really due to the presence of broken up and dead crustaceans, which had given free oil to the water.

* The species of Cyclops and Daphnia are usually between $\frac{1}{8}$th and $\frac{1}{16}$th of an inch in length.

Certain modifications of the oil which had been observed, could be traced to the *state* of the mass of crustaceans, before the ether was used as collected at the present time from a portion of water by means of filters of different degrees of fineness, from coarse to very fine, we have the water on one hand free from taste, while the filters retain the matter which rendered the water impure. A portion of this matter placed in pure water gives to it the taste of Cochituate water, while another portion under the microscope presents only living and dead crustaceans.

Dr. Bacon has kindly recorded his observations and allowed me to append his account of them to this paper.

Observations on the Oil contained in the Crustaceans found in the Cochituate Water, by John Bacon, M.D.

The occurrence of numerous transparent globules in the bodies of the minute crustaceans found in the Cochituate water, first attracted my notice in the spring of 1854, and I then ascertained by chemical tests that they consisted of oil. Supposing that they were *ova* in some stage of development and were probably well known to naturalists, no further observations were made until the bad condition of the Cochituate water attracted public attention; when I called the attention of one of the chemists employed to analyze the water to the presence of this oil and suggested that it might be the cause of the evil. But it did not appear probable to either of us that a small amount of oil could occasion so serious an effect: and thus the matter rested until the commencement of the present year, when Dr. Hayes placed in my hands for microscopical examination the gelatinous substance collected by him on cloth filters. The microscope revealed an abundance of oily globules, in the bodies of the Cyclops and other minute crustaceans, of which the mass on the filter chiefly consisted, and the source of the oil obtained in his experiments was at once evident. At this time, early in January, very few Conferva and other vegetable organisms were found. The empty silicious shells of various Diatomaceæ were abundant as usual, but scarcely any specimens were living, or contained organic matter. Yet the peculiar flavor of the water was as strongly marked, as in the autumn, when Conferva and other vegetable organisms abounded. The crustaceans in which the oil occurs are several species or varieties of Cyclops and Daphnia, and probably other allied genera of the division Entomostraca. In the living animals, the oil is clearly seen by the aid of the microscope, through the carapace which is mostly transparent; and it is distinguished by its high refractive power and other optical characters from the other contents of the shell. It can also be extracted by ether, and still more satisfactorily, by strong alcohol from the body of the animal, while in the field of the microscope. The quantity present is exceedingly variable, not only at different times, but in different individuals collected at the same time. In a few specimens no globules are visible. In others they are so abundant, that the oil forms at least one quarter part of the bulk of the animal. These large quantities occur only in the Cyclops, which is by far the most abundant form present; the other crustaceans contain much less.

Its distribution in the body of the animal is remarkable, being diffused irregularly in globules of various sizes, (usually spherical and occasionally ovoid or pear-shaped,) and in masses formed by the coalescence of globules; and it appears to have no definite connection with the internal organs of the animal. Sometimes, small globules are seen even in the last joints of the tail. No sac or envelop is visible around them, as they occur in the animal, or when liberated by tearing the body into fragments. Yet globules lying in contact in the body do not unite by moderate pressure, but regain their form when the pressure is removed.

A strong pressure causes them to run together. These facts are compatible with the absence of a proper enveloping membrane. No structure of any kind is visible in the globules. Their color, when isolated, is generally orange, red, or yellow; they range, however, from brownish red to an entirely colorless condition, in different specimens. As the carapace has frequently a tinge of red or green, the color of the oil is of course affected when seen through it.

Finding that the comparatively large size of the crustaceans, allowed of their almost perfect separation from the other bodies suspended in the water, by means of a suitable filter, a quantity was collected from a Cochituate service pipe, and thoroughly washed with distilled water. They were then introduced, mostly in a living state, into distilled water, in an open vessel. In about half an hour, the water began to acquire an odor, and after some hours, both the odor and taste resembled closely the peculiar flavor of the Cochituate. In a day or two, a decided fishy flavor was developed. The water was now somewhat milky, and on microscopic examination, an abundance of colorless oil globules, were seen diffused through it, with some gelatinous matter, derived from the bodies of the dead crustaceans, with the fragments of which, together with éxuviæ, the bottom of the vessel was covered. A large proportion were still living and active. In about a week, the water began to regain its clearness, and the odor and taste nearly disappeared. Many of the crustaceans were still alive; and it was noticed that a progressive diminution in the general amount of oil contained in their bodies, was evident in the successive examinations.

In the Cyclops, these globules are found equally in both sexes, and cannot therefore be derived from the ova; in many of the females, the granular ova masses, in the internal ovaries, are seen in company with the globules—but they are not in connection, nor is there any indication of a transition from one form to the other.

In the Daphnia, the small pellucid globules which constitute the earliest stage of the ova, and also the hibernating eggs, are visible in many specimens, and do not resemble the globules under consideration. The male Daphnia is rarely seen, and I do not know whether the oil is found in both sexes as in the Cyclops.

Since the above observations were made, I have learned, that these oil globules are briefly described by von Siebold. See Dr. Burnett's translation of von Siebold's Anatomy of the Invertebrata, pp. 310 and 334. This author regards them as fat cells, and after stating that they occur in many crustaceans, adds the following remarks: "The fat, which these cells contain plays a part, probably, in digestion and assimilation; for with these animals, the excess of nutriment is deposited as fat to be used in times of need, as for example, during the act of moulting. This explains why the quantity found is so variable, or even may be entirely wanting." I cannot find that they are described by other authors, nor are the appearances, which they present in the crustaceans of the Cochituate, represented in any of the figures I have seen.

Art. XXX.—*On Gum Mezquite;* by Campbell Morfit, M.D.

Gum Mezquite, known synonymously as *Muckeet*, *Mezqueet* and *Musquit*, and recently presented to public notice by Dr. G. G. Shumard, U. S. A., is said to be the product of a tree flourishing extensively in the high and dry regions of the plains of Western Texas, New Mexico and the adjacent Indian Territory. The facility with which it may be obtained in large quantities, and its very probable prospective value as an article of commerce, give it an interest that led me to a chemical examination, which I have caused to be made in my Laboratory by one of my students, Mr. Frederick W. Alexander.

It is a spontaneous semi-fluid exudation concreting by exposure into tears and lumps of variable size and form. Our sample, which was a part of that brought in by Dr. Shumard, and obtained directly from the U. S. Bureau of Indian Affairs, consisted of small irregular pieces and rounded balls about the size of a hazel nut, semi-transparent, and shading in color from a lemon white to dark amber. When broken, the fracture faces were brilliant; and the gum was easily reduced under the pestle to a dull white powder. One of the balls was enveloped with an outer pellicle of gum about $\frac{1}{16}$th of an inch in thickness.

The specific gravity of the gum was 1·5, but this determination may possibly admit of correction upon purer samples than were disposable for the experiment.

Its proximate composition was found to be,

Water, - - - - -	11.640
Foreign Matters, - - - -	0·236
Bassorin, - - - - -	0·206
Arabin, - - - -	84 967
Ash, - - - - -	3·000
	100 049

Cerasin was also sought for, but not found. The ash was estimated by burning a given quantity in an atmosphere of oxygen and weighing the residue.

The ultimate analysis, made also by effecting combustion of the carefully dried gum in oxygen gas, yielded, in two separate experiments, the following numbers:

	1.	2.
Carbon, - - -	43·63	43 10
Hydrogen, - - -	6·11	6 50
Oxygen, - - -	47·26	47·40
Ash, - - - - -	3·00	3·00
	100 00	100·00

These proportions approximate very closely to those obtained from gums Senegal and Arabic by Guerin and Mulder. The general appearance, too, of the gum is similar to that of gum Senegal, and the dark inferior qualities of gum Arabic. In chemical properties, also, it is allied to them; being insoluble in absolute alcohol, partially soluble in common alcohol, and readily forming with hot or cold water a very adhesive mucilage. It is in fine, a true gum, and promises, in its physical and chemical behavior, much of the advantage, expected by its discoverer, as an economical substitute for gum Arabic or Senegal.

University of Maryland, Baltimore, January, 10, 1855.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the elastic forces of vapors in vacuo and in gases at different temperatures, and on the tension of mixed vapors.*—Under this title Regnault has communicated to the Academy of Sciences the results of an elaborate series of investigations extending from the year 1843 to 1850 and now first made public. The author divides his communication into five parts. The first contains the results obtained on the elastic forces of saturated vapors furnished by a certain number of liquids selected from among those which are easily obtained in a state of purity, in quantity, and at a reasonable price.

The second part treats of the elastic forces of the vapors of saline solutions and of their application to the study of different phenomena of molecular physics and chemistry.

The third treats of the phenomena of the vaporization of liquids in gases.

The fourth of the results of experiments on the elastic forces of vapors furnished in vacuo by volatile liquids displaced or superposed.

The fifth contains the result of experiments undertaken to decide whether the tension of a vapor in vacuo depends or not on the solid or liquid state of the body which furnishes it.

The methods of observation employed to determine the elastic forces of vapors in vacuo are the same as those which the author used in studying the tension of the vapor of water. The author simply gives his results for alcohol, ether, bisulphid of carbon, chloroform and oil of turpentine, for every 10 degrees Centigrade. These are contained in the following table, the tension being expressed in millimeters.

	Alcohol.	Ether.	Bisulph. of carbon.	Chloroform.	Turpentine.
−21°	3·12	——	——	——	——
−20	3·34	69·2	——	——	——
−10	6·50	113·2	79·0	——	——
0	12·73	182·3	127·3	——	2·1
10	24·08	286·5	199·3	130·4	2·3
20	44·00	434·8	298·2	190·2	4·3
30	78·4	637·0	434·6	276·1	7·0
40	134·1	913·6	617·5	364·0	11·2
50	220·3	1268·0	852·7	524·3	17·2
60	350·0	1730·3	1162·6	738·0	26·9
70	539·2	2309·5	1549·0	976·2	41·9
80	812·8	2947·2	2030·5	1367·8	61·2
90	1190·4	3899·0	2623·1	1811·5	91·0
100	1685·0	4920·4	3321·3	2354·6	134·9
110	2351·8	6249·0	4136·3	3020·4	187·3
120	3207·8	——	5121·1	3818·0	257·0
130	4331·2	——	6260·6	4721·0	347·0
140	5637·7	——	——	——	462·3
150	7257·8	——	——	——	604·5
152	7617·3	——	——	——	——
160	——	——	——	——	777·2
170	——	——	——	——	989·0

The author remarks that these results were obtained partly by the direct measure of the tensions in vacuo and partly by the measure of the temperature which the vapor of the liquid presents when boiling under the pressure of an artificial atmosphere. The first method was used for low and the second for high temperatures. In all cases the experiments were made in such a way that the curves of the elastic forces given by the two methods, presented a part in common so as to permit the observer to judge of their coincidence. This coincidence was in the author's former experiments perfect for the vapor of water; he finds it to be perfect also for other volatile liquids provided that these are chemically pure. When however an extremely small quantity of another volatile substance is present, the two methods give different values for the elastic force of the vapor at the same temperature, and this gives an extremely delicate method of judging of the homogeneity of a volatile substance. The author found it easy to obtain perfectly pure bisulphid of carbon, but difficult to get pure ether and alcohol, while chloroform always contains many substances mixed with it which cannot be separated. Thus the tension of its vapor as directly determined was 342·2 at 36°, while by the method of ebullition it was found to be 313·4 at the same temperature. Some liquids change their molecular structure when long boiled under high pressures, and of this change oil of turpentine furnishes a remarkable example. Other liquids appear to undergo molecular changes when left to themselves for a long time in hermetically sealed tubes: ether is a curious instance of this.

With respect to the second part of the subject, as indicated above, the author in the first place verified the law of Rudberg, that whatever be the boiling point of a saline solution the vapor has simply the temperature which it would have if disengaged from pure water. As however the experiments of Rudberg were made only at ordinary atmospheric pressures, Regnault endeavored to extend our knowledge of the subject by studying the phenomena of the ebullition of saline solutions under very different pressures. The apparatus used was a copper boiler through the cover of which four closed tubes passed, two into the liquid beneath and two into the vapor above. The tubes contained a small quantity of mercury and served to contain the thermometers. A tube communicating with a refrigerator served to condense the vapor while the refrigerator itself communicated with a large reservoir of air, the pressure of which could be varied at pleasure. Concentrated solutions of chlorid of calcium were placed in the boiler and made to boil under various pressures while at the same time the temperatures of the liquid and the vapor were measured. The author gives two tables of his results, of which however our limits permit us to give but one. In this table the first column gives the pressures corresponding to the temperatures observed, the second the temperatures of the liquid, the third the temperature of the vapor and the fourth the temperature which the vapor would have had if it had been produced by distilled water boiling under the same pressure.

1.	2.	3.	4.	1.	2.	3.	4.
mm.	°	°	°	*mm.*	°	°	°
82·52	52·0	47·88	47·84	757·22	——	99.88	99·90
136·61	61·58	58·20	58·16	1807·15	129·86	126·63	126·16
219·44	71·80	68·73	68·61	2182·35	136·30	132·92	132·42
286·43	——	74·94	74·84	2702·13	142·79	140·35	139·81
434·19	87·54	85·09	85·07	3123·69	147·91	145·57	145·00

It will be seen from this table that the thermometer plunged into the vapor constantly indicates a temperature a little higher than that which corresponds to the vapor of pure water under the same pressure. The small difference may be attributed to radiation from the hotter liquid and to small drops of liquid projected by the boiling saline solution. The thermometers plunged into the liquid indicated abrupt variations, sometimes of several degrees. It may then be admitted that the law of Rudberg holds good for pressures much higher and much lower than the ordinary pressure of the atmosphere. By placing the bulb of the thermometer in different parts of the space above the liquid, the author found that, at a distance of 3 or 4 centimeters above the surface of the solution, the thermometer was always wetted and consequently could only indicate the temperature of the vapor of pure water. When the bulb descends toward the surface the temperature rises but the bulb dries and this drying takes place only in the layers of vapor immediately above the liquid. This appears therefore to give the explanation of the fact observed by Rudberg; the vapor has at first the temperature of the saline solution, as it rises however it parts with its excess of heat in consequence of its low specific heat as compared with its volume, and thus at a certain height above the surface of the liquid has only the temperature which it would have if coming from pure water. As it was found impossible to determine the temperature of the ebullition of saline solutions so as to deduce from these observations certain results, the author directed his attention to the elastic forces of the vapors which these solutions emit in vacuo. These tensions may be determined with great accuracy and their observation has already led to most interesting and valuable results. Thus when any molecular change takes place in the substance dissolved, it is immediately manifested by a singular point in the curve of the elastic forces of the vapor furnished by the solution. Regnault suggests therefore that the study of the tensions of the vapor of saline solutions promises to yield results as important as those which Biot has deduced from the phenomena of circular polarization.

It is generally admitted by physicists that vapors behave in gases as in vacuo, excepting that in gases the equilibrium of tension is established slowly, while in vacuo this takes place instantaneously. The experiments of Regnault on this point confirm those of Magnus and conclusively show that elastic force of a vapor in a gas is less than in vacuo. The apparatus employed was the same as that used by the author in his former researches on the tension of the vapor of water and consisted of a vessel of 600 or 700 C. C. capacity communicating with a mercurial manometer. The whole apparatus was placed in a large vessel filled with water kept at a constant temperature. The vessel was then filled with dry air and the tension of this first determined at different temperatures. A small glass bulb previously filled with the liquid to be examined and introduced into the glass vessel was then broken by heating the vessel sufficiently; the vapor thus produced caused the mercury in the manometer to descend and its elasticity therefore could easily be measured. The following table gives the results of a single series of experiments on the tension of air containing the vapor of ether, the first column giving the temperature, the second the elastic force of the vapor in the air, the third the elastic force of the vapor in vacuo, and the fourth the difference between these two tensions.

°			mm.	°			mm.
5·17	225·94	232·5	6·6	11·09	297·10	300·2	3·1
14·42	340·15	345·3	5·1	11·11	296·78	300·6	3·8
14·38	336·48	334·5	8·0	19·37	414·02	423·1	9·1
20·78	439·50	445·6	6·1	12·22	311·30	315·0	3·7

Precisely similar results were obtained with a different form of apparatus, with different vapors in air, and with the vapor of ether in different gases. With this second form of apparatus the author also studied the influence exerted on the tension of the vapor by the total pressure of the atmosphere which acts on the liquid and by the quantity of liquid in excess which moistens the sides of the containing vessel. The author's conclusion is that the law of Dalton on mixed gases and vapors may be regarded as a theoretical law which would probably be verified with all rigor in a vessel the walls of which should be formed by the volatile liquid itself of a certain thickness, but this law is inaccurate in our apparatus because the hygroscopic affinity of the matter of the vessel brings the vapor to a tension which is variable and which is always inferior to that which corresponds to saturation. Thus the table which we have given above gives the *maximum* tension of the vapor of ether in air at the temperatures mentioned. The tension of the vapor at the moment that dew begins to deposit on the vessel is far from being equal to that of the vapor in vacuo. If we compress the gaseous atmosphere the condensed liquid becomes more abundant and the tension of the vapor increases and approaches more and more the tension in vacuo. But it only becomes equal to this when a thick layer of liquid is found on the surface of the mercury and when the observation is made immediately after the reduction of volume.

As the result of his experiments on the tension of the vapor of mixed volatile liquids in vacuo, the author finds that two volatile liquids which are not capable of dissolving each other give in vacuo a tension of vapor equal to the sum of the tensions which these substances present separately. It is however only in this case that the law of Dalton is verified. Whenever the liquids mutually dissolve each other, the tension of the vapor is in general less than that which would be produced by the most volatile liquid separately. The difference is greater the less the proportion of the less volatile liquid.

With respect to the last of the subjects of investigation undertaken, the author found that the vapor of liquid acetic acid below the temperature of condensation possesses a higher tension than that of the solid acid at the same temperature. He attributes this however, to the presence of small quantities of foreign substances which in the case of the liquid acid are disseminated throughout the whole mass and therefore exert but a slight influence on the tension of the vapor. In the act of congelation however, the impurity separates from the mass, and therefore must exert a much greater influence on the tension.—*Comptes Rendus*, xxxix, 301, 391, 345, *August*, 1854.

2. *On butylic Alcohol.*—Wurtz has obtained butylic alcohol in considerable quantity by the fractionated distillation of certain varieties of fusel oil. These contained common alcohol, and the corresponding compounds of amyl and butyl, but not that of propyl which Chancel has found in the fusel oil of brandy. Perfectly pure butylic alcohol was obtained by decomposing pure iodid of butyl obtained from the raw alcohol, by means of acetate of silver, and then decomposing the acetate of butyl by caustic potash. It is a colorless liquid more fluid than amylic alcohol, and having a somewhat similar but more vinous odor. It does not deflect the plane of polarization, boils at 109° C. and has a density at 18°·5 of 0·8032. The density of its vapor is 2·589, and corresponds to 4 volumes. It takes fire readily and burns with a luminous flame; it is soluble in 10·5 times its own weight of water at 18°; with potassium and sodium it forms potassic and sodic alcohol; heated with soda lime it gives butyrate of soda. Sulphuric acid forms with it sulpho-butylic acid when the mixture is kept cool, but

at common temperatures decomposes it, forming various hydrocarbons. Chlorid of zinc gives with the alcohol, butene C_8H_8, hydruret of butyl C_8H_{10}, and liquid carburets. By the action of potassium on iodid of butyl the author obtained butyl C_8H_9, (or in Gerhardt's view, $\left.\begin{matrix}C_8H_9\\C_8H_9\end{matrix}\right\}$); it is a colorless oily liquid. The chlorid, iodid and bromid of butyl were found by the usual processes; they are liquid and resemble corresponding compounds of amyl. The iodid of butyl readily reacts with the salts of silver, and in this manner many of the ethers of this radical may be obtained. Wurtz did not succeed in preparing the oxyd of butyl in a perfectly pure state; it appears to be a liquid having an agreeable odor and boiling between 100 and 105°. The carbonate, acetate, nitrate and formate of butyl are all liquid and do not require special notice in this place. By distilling sulpho-butylate of potash with cyanate of potash, dissolving the distillate in alcohol and then distilling this mixture with caustic potash, the author obtained butylamin. In a pure state this ammonia $N\left\{\begin{matrix}C_8H_9\\H\\H\end{matrix}\right.$ is liquid and boils at 69°–70°; it is soluble in water, alcohol and ether, and the aqueous solution is extremely caustic and precipitates most metallic solutions like ammonia itself; it dissolves alumina and even gelatinous silica. The platinum salt of this base is $C_8H_{12}NCl+PtCl_2$; the gold salt is $2C_8H_{12}NCl+AuCl_3$. The author points out the fact that butylamin has the same boiling point with petinin, with which it is possibly identical.—*Ann. de Chemie et de Physique*, xlii, 129.

3. *On the volumetric determination of Copper.*—De Haen has succeeded in applying the general method of Bunsen to the determination of copper by means of the well known reaction $2CuO, SO_3+2KI=Cu_2I+2KO, SO_3+I$. The details of the process are as follows: The copper is to be brought into the form of sulphate, the solution being either neutral or containing only a moderate quantity of free sulphuric acid. The solution is then to be diluted in a measuring flask to a definite volume, so that 100 C. C. contain 1–2 gr. of oxyd of copper; 10–20 C. C. of Bunsen's solution of KI are to be introduced into a large beaker glass; 10 C. C. of the solution of copper are to be added and the whole mixed; the solution of sulphurous acid is then to be added, and the operation finished by Bunsen's process. The presence of free nitric, chlorhydric and acetic acids, as well as of oxyd of iron and all other substances which decompose iodid of potassium must be avoided. The sulphurous acid must also be added without loss of time and the solutions must not be too dilute. If these conditions be observed a very accurate result is obtained.—*Ann. der Chemie und Pharmacie*, xci, 237. [It will be observed that this method fails entirely precisely in the case in which it is most desirable to have a very accurate and expeditious process for determining copper, namely, in the assay of copper ores. —W. G.]

4. *On the action of iodid of amyl upon an alloy of sodium and tin.*—Grimm has studied and described an extensive series of new radicals containing tin and the elements of amyl, and obtained by the action of iodid of amyl upon an alloy of tin and sodium. As however, these

radicals do not differ essentially in properties from those already described by Löwig and other chemists, we shall content ourselves with giving their formulas and names, Am being employed as a symbol for amyl.

Methstannbiamyl, - - -	$Sn_2\,Am_4$
Methstannamyl, - - - -	$Sn_2\,Am_3$
Methylenstannamyl, - - -	$Sn\,Am_2$
Stannamyl, - - - - -	$Sn\,Am$
Bistannamyl, - - - -	$Sn_2\,Am$

It will be observed that these compounds correspond to those of ethyl and tin, but that while the amyl compound corresponding to ethstannethyl Sn_4Am_5 is wanting a radical is here met with to which the ethyl series affords no parallel, namely, Sn_2Am_4.—*Journal für practische Chemie*, 62, 34.

5. *New organic radicals containing arsenic.*—CAHOURS and BRELIE have still further extended our knowledge of this very interesting class of bodies. By the action of iodid of methyl upon arseniuret of sodium two radicals are obtained, one corresponding to stibmethyl, the other the iodid of an arsenic ammonium which the authors term arsenmethylium. This iodid is represented by $(C_2H_3)_4As\,.\,I$, and crystallizes in magnificent brilliant tables. By double decomposition with the salts of silver other salts may be readily obtained. The same radical is also obtained when iodid of methyl is brought into contact with cacodyl, the action being represented by the equation $2C_2H_3I + 2C_4H_6As = (C_2H_3)_4As\,.\,I + C_4H_6AsI$. With the iodids of ethyl and amyl similar results are obtained, and the iodids of two new arsenic ammoniums are formed having the formulas $(C_2H_3)_2(C_4H_5)_2As\,.\,I$ and $(C_2H_3)_2(C_{10}H_{11})_2As\,.\,I$. These results in connection with those of Landolt already mentioned in this Journal, leave no doubt as to the constitution of cacodyl which must be regarded as Dimethyl-arsenic.—*Comptes Rendus*, xxxix, 541.

[*Note.*—In connection with this subject the writer desires to draw the attention of chemists and of medical men to the probable advantages of employing the nitrogen, antimony and arsenic *ammoniums* in place of quinine as antiperiodic therapeutic agents. It will be remembered that the compound ammoniums of Hoffmann, tetramethyl-ammonium $N(C_2H_3)_4$ for instance, possess in their saline compounds an intensely bitter taste. Now as quinine in combination is also an ammonium, NR_4, it appears probable that the bitter taste is in some measure at least, characteristic of the type $R'R_4$ of the ammoniums. This appears to be the case with the antimony and arsenic ammoniums so far studied, and I therefore suggest that careful experiments should be made to determine whether these compound ammoniums which can readily be prepared in the laboratory and at moderate prices may not answer in intermittent fevers, &c. as well as the expensive salts of quinine.—W. G.]

6. *Action of iodid of phosphorus upon glycerine.*—BERTHELOT and de LUCA have observed that when crystallized iodid of phosphorus PI_2 is distilled with glycerine propylene gas is evolved, while water and iodated propylene C_6H_5I distill over. The proportions of these products

vary with those of the materials employed. Iodated propylene is a colorless liquid boiling at 101° C. It is rapidly colored by the action of air and light, and then emits very irritating vapors: its density is 1·789 at 16° C. A solution of ammonia after forty hours action at 100° completely decomposes iodated propylene; the product is a volatile alkali, which according to the authors, has the formula C_6H_9N and appears to be propylamin $C_6H_7 . NH_2$ (?). Heated with mercury and chlorhydric acid the iodated propylene is decomposed, yielding propylene; the reaction is represented by the equation $C_6H_5I + HCl + 4Hg = C_6H_6 + Hg_2Cl + Hg_2I$. The authors recommend this process for the preparation of propylene. Propylene unites directly with iodine when the mixture is exposed to the sun's light, and yields a heavy colorless liquid having the formula $C_6H_6I_2$; the authors term it iodid of propylene.—*Comptes Rendus*, xxxix, 745. W. G.

II. Geology, Botany, Zoology.

1. *Darstellung der Flora des Hainichen-Ebersdorfer und des Flöhær Kohlenbassins;* by H. B. Geinitz. 80 pp. large 8vo, with 14 copper plates in large folio. *Leipzig*, 1854. Gekrönt und herausgegeben von der fürstlich Jablonowskischen Gesellschaft zu Leipzig.—Dr. Geinitz, the accomplished geologist and Palæontologist of Leipzig, has made in this new work of his, a most valuable contribution to the science of the Coal Formation, and particularly that of Saxony. The work contains an account of the older coal measures in the neighborhood of Hainich and Ebersdorf in Saxony, which is synchronous with the carboniferous limestone, and also descriptions of the true coal formations from the neighborhood of Flöha near Chemnitz and Zwickau. The Hainichen-Ebersdorf beds present two members, a conglomerate below, and a coal-bearing sandstone above associated with clay shale, the former in some places at least 2000 feet thick, the latter about 1700 feet. The Flöha basin, contains, commencing below, 1, a lower sandstone with some some thin coal seams; 2, a gneis oid conglomerate, metamorphic; 3, a Felsite porphyry, an eruptive rock; 4, an upper sandstone with clay slate and thin coal seams; 5, claystone. The older coal rocks afford—an Annelid-like species, named *Gordius carbonarius* G. near the *Nemapodia tenuissima* of Emmons (Tacon. Syst., pl. 2, fig. 1); also the coal plants *Calamites transitionis* Göp., *C. Römeri* Göp., *Sphenophyllum furcatum* Lind.—*Sphenopteris distans* Sternb., *Hymenophyllites quercifolius* Göp., *Cyclopteris tenuifolia* Göp., *Cyatheites asper* Brongn., *Lycopodites dilatatus* L. and H., *Lepidodendron tetragonum* Sternb., *Sagenaria Veltheimiana* Sternb., *S. caudata* Presl., *S. polyphylla* Römer, *Halonia tuberculosa* Brongn., *Knorria imbricata* Sternb., *Stigmaria inæqualis* Göp. The Sagenariæ are the common species. The Stigmariæ appear according to Geinitz, to be in the Hainich region the roots of the Sagenariæ, and he quotes Richard Brown respecting the Stigmariæ pertaining sometimes to Lepidodendra as well as Sigillariæ. On one plate is represented a leaf supposed to belong to a true Sigillaria. The plates illustrating this memoir are exceedingly beautiful, and of very large size.

Dr. Geinitz is engaged on a still larger work on the Flöha coal formation to contain 35 plates.

2. *A Monograph of the Cirripedia with figures of all the species; the Balanidæ or sessile Cirripedes, the Verrucidæ, etc.;* by CHARLES DARWIN, F.R.S., F.G.S. 684 pp., 8vo, with 30 copper plates. 1854. *London.* Ray Society.—The volume by Mr. Darwin on the Lepadidæ or pedunculated Cirripedes, published in 1851, was noticed in a former volume of this Journal, and also his memoir on the Fossil Lepadidæ, published by the Palæontographical Society. We welcome with peculiar pleasure its successor which completes the subject. Mr. Darwin's works are the result of great labor and extreme care, and have a critical accuracy which entitles them to the highest confidence. In the work just issued, the anatomical structure of species of the different groups is thoroughly made out and much that is new presented. The nervous system is brought out complete, even to the nerves passing to the eyes. The remarkable peculiarities of the genera Cryptophialus and Alcippe, pedunculate Cirripeds, are well detailed. Mr. Darwin shows that the sexes are distinct as in Ibla and Scalpellum; while all the Balanidæ are hermaphrodites. We might cite largely from the work to the advantage of our readers, but refer them to the volume, which has the high value of giving figures of all the species, as well as good descriptive details.

III. ASTRONOMY.

1. *Elements of Euphrosyne* (31), (Astron. Jour., 79.)—The asteroid discovered on the first of Sept. last by Mr. James Ferguson, has received the name EUPHROSYNE. The following elements of its orbit have been computed by the discoverer from Washington observations of Sept. 2, 6, 10, 29 and 30: Oct. 5, 7, 30 and 31: Nov. 2, 4 and 5; giving the three following normal places referred to the mean equinox of 1856·0.

M. T. Berlin.	R. A.	Dec.
Sept. 5·0	$1^h\ 51^m\ 21^s{\cdot}79$	$-2°\ 54'\ 48''{\cdot}11$
Oct. 5·0	1 28 11 ·00	2 26 54 ·78
Nov. 4·0	0 56 39 ·88	−0 57 56 ·13

Epoch 1854 Sept. 14·0 M. T. Berlin.

Mean anomaly, - -	300° 57′ 52″·62	
Long. perihelion, - -	94 0 37 ·73	Mn. Eqnx. 1856·0
" asc. node, -	31 24 24 ·21	
Inclination, - - -	26 28 21 ·3	
Angle of excentricity, -	12 31 23 ·7	
Log. mean daily motion,	2·8008456	
" semi-axis major	0·4994407	

IV. MISCELLANEOUS INTELLIGENCE.

1. *On an Atmospheric Electrical Phenomenon;* by H. WARE, (from a letter to Prof. Silliman, dated Cambridge, Mass., Jan. 25, 1855.)—My friend, Mr. J. M. Batchelder wrote me a few days since that you would like some fuller account of a remarkable electrical phenomenon seen by me, than he was able to give, and it gives me pleasure to comply with his request, though regretting that the matter had not come under the notice of some more competent observer.

On Sunday evening, Dec. 17, 1854, while walking over the West Boston bridge (the long bridge across the Charles River, between Boston and Cambridge), my attention was attracted, when about half way across (the bridge is 2483 feet long), by a loud hissing noise proceeding from the iron lamp-posts, which, for a moment, I supposed to be caused by steam from the snow melting on the lanterns, but, after examining several, found this to be a mistake. After some time I felt a succession of sharp pricks on my forehead, and raising my hand to remove my hat, was surprised by seeing a brilliant discharge of electric sparks wherever my fingers touched or approached the rim of my hat (which was of felt). This gave me a new hint, and, coming soon after to a part of the bridge where the lamps were extinguished I saw from the ventilator on the top, and from every angle and point of the lantern, long streams of electric light, streaming out for some 6 or 8 inches, (somewhat in the fashion depicted in the figure.) Holding up my cane, the same appearance was observed, the light streaming in every direction from the steel ferule (which was quite large) for 3 or 4 inches; and the same phenomena were noticed appearing from the tips of my fingers which were covered by *woollen* gloves. The sound was quite loud, not only from the lamp-posts, but also from my hat, cane and fingers; that from the *lanterns* being heard very loud quite across the bridge, which is 40 feet wide, and from a number of lamps at the same time, they being perhaps 200 feet apart; the sound resembled that of blowing off steam, as it seemed, at first; but was more like the drawing off of a *continuous* stream from an electrical machine to a jar, only of course vastly louder than I ever heard in that way. I observed that these displays were to be seen only at a height of some 5 feet from the pavement of the bridge (which at high tide is some 6 feet above the water), and I think, though am not confident, *only* on that part of the structure which is filled in *solid*, being some 600 feet on the Cambridge end, the rest of it being built on *piles*. The phenomenon diminished in intensity as I approached the Cambridge end and ceased entirely on gaining terra firma. This was between 11 and 12 o'clock at night, snowing fast and the wind strong from the northeast; high tide at 9.10 P. M. Had Cambridge not been so far off and the hour so late I should have roused some of my friends, the philosophers, from their slumbers that they might have taken more intelligent observations than my ignorance was equal to. I spent more than half an hour in the storm, amusing myself with such tests as occurred to me, and hoping that some other person would come along whose attention I could direct to the phenomenon, but failed even to meet a watchman.

2. *On the Clearness of the Atmosphere in Oroomiah;* by Rev. D. T. STODDARD, (from a letter addressed to Sir John F. W. Herschel, dated Oroomiah, Persia, N. Lat. 37° 28′ 18″, Long. E. from Greenwich 45° 1′, November 23d, 1852, and published in the Proc. of the Amer. Oriental Society, 1853, p. 3.)—Presuming that a letter written to you from ancient Media, and relating to your favorite science, will not be unacceptable, I shall make no apology for the liberty I take in addressing you. My home is in Northern Persia, where I have resided for the last nine years, as an American Missionary to the Nestorian Christians. To give

you an idea of our geographical position, I have noted, above, our latitude and approximate longitude. As I wish also to give you a glance at the physical features of this region, let me invite you to come with me upon the flat, terraced roof of my house, where I am sure you will be delighted with the scene before you. Standing at an elevation of more than a mile above the ocean, and a thousand feet avove the adjoining country, you may look down upon one of the loveliest and most fertile plains in all the East. Extending for forty miles in length, and from twelve to fifteen in breadth, the district of Oroomiah smiles with hundreds of villages, is verdant with thousands of orchards, and rows of poplars, willows and sycamores by the water-courses, and in the early summer waves with innumerable fields of golden grain. Here the peach, the nectarine, the apricot, the quince, the cherry, the pear, the apple, and the vine, flourish in luxuriance, and give the appearance of a variegated forest. Beyond the plain, you see the lake of Oroomiah, reflecting the purest azure, and studded over with numerous islands, while further on rise distant and lofty mountains, their outlines projected on the cloudless Italian sky, and forming a beautiful contrast with the plain before you. The city of Oroomiah, about six miles distant, which is so embosomed in trees as almost to be hidden from view, is the probable birth-place of Zoroaster; and the mounds which are so conspicuous in different parts of the plain, and which are formed entirely of ashes with a scanty soil upon them, are supposed to be the places where the sacred fire was ever kept burning, and the Persian priests bowed in adoration to the rising sun.

The temperature of this elevated region is very uniform, and the greater part of the year very delightful. During the months of June, July, August, September, and sometimes October, there is little rain, and the sky is rarely overcast. Indeed, I may say that often for weeks together not a cloud is to be seen. As a specimen of the climate in summer, I send accompanying this my meteorological register for the month of August last. The observations were taken at our house on Mt. Seir, but do not differ essentially from those taken on the plain at the same season, except that the thermometer is here a few degrees lower, and the air somewhat drier, especially at night.

No one has ever travelled in this country, without being surprised at the distinctness with which distant objects are seen. Mountains fifty, sixty, and even a hundred miles off, are projected with great sharpness of outline on the blue sky; and the snowy peak of Ararat, the venerable father of mountains, is just as bright and beautiful when two hundred miles distant, as when we stand near its base. This wonderful transparency of the atmosphere frequently deceives the inexperienced traveller; and the clump of trees indicating a village, which seems to rise only two or three miles before him, he will be often as many hours in reaching.

In this connection, you will be interested to know that the apparent convergence of the sun's rays, at a point diametrically opposite its disc, which, if I mistake not, Sir D. Brewster speaks of as a very rare phenomenon, is here so common that not a week passes in summer when the whole sky at sunset is not striped with ribbons, very much like the meridians on an artificial globe.

But it is after nightfall that our sky appears in its highest brilliancy and beauty. Though accustomed to watch the heavens in different parts of the world, I have never seen anything like the splendor of a Persian summer evening. It is not too much to say that, were it not for the interference of the moon, we should have seventy-five nights in the three summer months, superior for purposes of observation to the very finest nights which favor the astronomer in the New World. When I first came here, I brought with me a six-feet Newtonian telescope, of five inches aperture, of my own manufacture ; and though the mirrors have since been much tarnished, and the instrument otherwise injured, its performance is incomparably superior to what it was in America. Venus sometimes shines with a light so dazzling that at a distance of *thirteen feet* from the window I have distinguished the hands of a watch, and even the letters of a book.

Some few months since, having met with the statement that the satellites of Jupiter had been seen without a glass, by a traveller on Mt. Etna, it occurred to me that I was in the most favorable circumstances possible for testing the power of the unassisted eye, and I determined at once to make some experiments on the subject. My attention was, of course, first turned to Jupiter, but, for a considerable time, with no success. It was always so bright, and shot out so many rays, that it seemed quite impossible to detect any of its moons, even at their greatest elongation from the planet. I varied the experiment in several ways, by looking through the tube of a small telescope, from which the lenses had been taken, and also by placing my eye near the corner of a building, so as to cut off the most brilliant rays of the planet, and yet leave the view unobstructed to the right hand or the left; but in neither case could I find any satellite. Some time after, I was sitting on the terrace as daylight was fading into darkness, and thought I would watch Jupiter from its first distinct appearance, till it shone out in its full splendor. This time I was exceedingly gratified, just as stars of the first and second magnitude were beginning to appear, to see two extremely faint points of light near the planet, which I felt sure were satellites. On pointing my telescope towards them, my first impressions were confirmed, and I almost leaped for joy at my success. Since that night, I have many times, at the same hour of the evening, had a similar view of these telescopic objects, and think I cannot be mistaken as to the fact of their visibility. I must, however, add that none of my associates, who at my request have attended to the subject, are *sure* that they detect them, though the most sharp-sighted individual feels some confidence that he can do so. As these friends, however, are not practical observers, their failure to see the satellites does not shake at all my belief that I have seen them myself.

The time during which these satellites are visible is hardly more than ten minutes. The planet itself soon becomes so bright that they are lost in its rays. I will not stop to discuss the question, in itself a most interesting one, why they are visble at all, when stars of the third and fourth magnitudes are not distinguishable, but merely give you the facts in the case, knowing that you will reason on them much better than I can. Both the fixed stars and the planets shine here with a beautifully steady light, and there is very little twinkling when they are forty degrees above the horizon.

Having come to a satisfactory conclusion about the satellites of Jupiter, I turned next to Saturn. This planet rose so late in the night that I had not seen it while watching Jupiter, and I was curious to know whether any traces of a ring could be detected by the naked eye. To my surprise and delight, the moment I fixed my eye steadily upon it, the elongation was very apparent, not like the satellites of Jupiter, at first suspected, guessed at, and then clearly discernible, but such a view as was most convincing, and made me wonder that I had never made the discovery before. I can only account for it from the fact that, though I have looked at the planet here with the telescope many times, I have never scrutinized it carefully with the naked eye. Several of my associates, whose attention I have since called to the planet, at once told me in which direction the longer axis of the ring lay, and that too without any previous knowledge of its position, or acquaintance with each other's opinion. This is very satisfactory to me, as independent collateral testimony.

I have somewhere seen it stated, that in ancient works on astronomy, written long before the discovery of the telescope, Saturn is represented as of an oblong shape, and that it has puzzled astronomers much to account for it. Am I not correct in this impression? and, if so, is it not possible that here, on these elevated and ancient plains, where shepherds thousands of years ago watched their flocks by night, and studied the wonders of the glorious canopy over their heads, I have found a solution of the question?

After examining Saturn, I turned to Venus. The most I could determine with my naked eye was, that it shot out rays unequally, and appeared not to be round; but, on taking a dark glass, of just the right opacity, I saw the planet as a very minute, but beautifully defined, crescent. To guard against deception, I turned the glass in different ways, and used different glasses, and always with the same pleasing result. It may be that Venus can be seen thus in England, and elsewhere, but I have never heard of the experiment being tried.

Let me say here, that I find the naked eye superior for these purposes to a telescope formed of spectacle glasses, of six or eight magnifying power. This is not, perhaps, very wonderful, considering that in direct vision both eyes are used, without the straining of any one of the muscles around them, and without spherical or chromatic aberration, or the interposition of a dense medium.

As I am an entire stranger, and at the same time am desirous of having these statements make their full impression on your mind, it is proper for me to say that I was formerly for several years a pupil of Professor Olmsted of Yale College, New Haven, and have since been admitted to his special friendship; and that I was associated for some time in observations with young Mason, whose early death you have spoken of as a loss to the astronomical world. And though, no doubt, very many persons have more accurate habits of observation than myself, a practice of fifteen years has done much to train my eye for researches like these.

You will also bear in mind the great dryness of our atmosphere, indicated by the register, as well as our great elevation. Capt. Jacob, (Proceedings of the Edinb. Royal Society, vol. ii, No. 36,) in speaking of the extinction of light in the atmosphere, says: "The loss of light in passing from the zenith through a homogeneous atmosphere of

5·2 miles will be ·303. I was much astonished at first discovering that the air had so great absorbent powers, and many ideas are suggested by the fact."

My letter is already becoming tedious, but I will venture to trespass on your patience further, by naming a few test-objects, which will enable you the better to compare the advantages of our position with your own.

1. δ Cephei. This I have looked at repeatedly with my naked eye, and though I cannot be *sure* that I have seen it double, I put it down, in astronomical language, as "strongly suspected."

2. The two small stars in the neighborhood of the pole-star, and in the general direction, of γ Cephei (thus . P ·.) are seen distinctly, and almost every night, as a single point of light.

3. 4 and 5 ε Lyræ are very beautiful and well defined. When lying on my back, the view of these stars, as they have passed near the zenith, has been very similar to that I have often had of Castor in a good telescope. There being *no dew* here, it is almost the universal custom for the people to sleep upon the terraced roofs, which gives them an opportunity, if so disposed, to gaze upon the blue vault above them.

4. α Libræ is seen as two stars in any ordinary state of the atmosphere, as readily as α Capricorni would be in America.

5. Mizar and Alcor in Ursa Major. On looking at these any favorable night, two faint stars, which must be telescopic in England, are distinctly seen. They appear somthing like this (· ·80 ζ· ·).

As I am absorbed in other and pressing labors, which allow me to devote only an occasional thought to astronomical pursuits, and as, besides, I am not furnished with any first rate instruments, allow me to suggest the great desirableness of some experienced observer's coming here to avail himself of this magnificent climate. One who should spend even a limited period in Oroomiah, might safely promise himself a good, and perhaps a very rich, harvest of astronomical discovery.

The averages of the meteorological register for August, alluded to above, were as follows :

Barometer reduced.

Sunrise.	2 P. M.	10 P. M.
24·246	24·247	24·235

General average, 24·242
Barometer highest, 24·417
" lowest, ·097

Difference, ·320

Fahrenheit's Thermometer.

Sunrise.	2 P. M.	10 P. M.
67°·4	79°·45	71°·37

General average of the three observations, 72°·74.

Hygrometer—wet bulb.

Sunrise.	2 P. M.	10 P. M.
54°·82	60°·43	55°·37

General average from the above, 56°·87

Average difference of Hygrometer and Thermometer, 15°·87.
" " " " " " at 2 P. M., 19°·02.

Greatest change of Thermometer in 24 hours, 18°.

N. B. The daily observations differ but little from the weekly average. One day follows another with great uniformity.

3. *Abstract of Meteorological Observations made at Burlington, Vt., in* 1854; by Z. Thompson.—The location where the observations were made, is one mile east from Lake Champlain and 256 feet above it (346 above the sea) in Lat. 44° 29′, and Long. 73° 11′.

1854.	THERMOMETER.				BAROMETER.			
Months.	Mean.	Highest.	Lowest.	Range.	Mean.	Highest.	Lowest.	Range.
	°	°	°	°	Inches.	Inches.	Inches.	Inches.
January, . .	19·57	53	−17	70	29·74	30·41	28·85	1·56
February, .	16·31	46	−12	58	29·80	30·41	29·18	1·23
March, . .	30·18	56	6	50	29·61	30·08	28·84	1·24
April, . . .	39·21	69	17	52	29·73	30·27	29·22	1·05
May, . . .	57·77	83	27	56	29·66	30·01	29·30	·71
June, . . .	64·03	86	40	46	29·64	29·93	29·35	·58
July, . . .	73·95	99$\frac{2}{3}$	52	47$\frac{2}{3}$	29·75	29·98	29·51	·47
August, . .	68·85	91	49	42	29·72	30·00	29·41	·59
September, .	60·10	95	34	61	29·77	30·18	29·20	·98
October, . .	51·10	76	30	46	29·77	30·17	29·08	1·09
November, .	37·63	63	13	50	29·53	30·21	28·80	1·41
December, .	17·76	42	−21	63	29·64	30·46	28·84	1·62
Annual result,	44·71	99$\frac{2}{3}$	−21	120$\frac{2}{3}$	29·70	30·46	28·80	1·66

1854.	WINDS.								WEATHER.		SNOW.	WATER.
Months.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Fair.	Cloudy.	Inches.	Inches.
January, .	10	1	0	2	11	1	4	2	20	11	14	1·82
February, .	9	2	1	2	7	0	4	3	17	11	17	1·65
March, . .	8	0	1	2	11	1	4	4	19	12	7	1·69
April, . .	15	0	1	1	9	1	1	2	19	11	12	3·60
May, . .	9	1	1	2	12	1	1	4	26	5	0	1·62
June, . .	15	1	0	0	12	1	1	0	23	7	0	2·88
July, . .	8	0	1	1	16	1	2	2	30	1	0	1·60
August, .	9	2	1	2	11	1	4	1	29	2	0	0·61
September,	10	2	0	1	15	0	0	2	26	4	0	4·44
October, .	6	1	1	1	18	0	1	3	23	8	1	2·26
November,	6	0	0	3	11	1	4	5	15	15	6	2·17
December,	6	2	1	1	12	2	3	4	18	13	21	1·11
	111	12	8	18	145	10	29	32	265	100	78	25·45

The results in the preceding tables were derived from three daily observations, made at sunrise, 1 P. M., and 9 P. M.* The warmest day in the year was the 4th of July, the mean temperature of which was 85°, and the coldest was the 22d day of December the mean of which was −14$\frac{2}{3}$°. The greatest cold in the year, was −21°, at 6 o'clock in the morning of the 20th of December. The mean temperature of the year was 0°·15 colder than the average of the preceding sixteen years, and 0·51 colder than 1853. The range of the thermometer was 14$\frac{2}{3}$° greater, and that of the barometer 0·30 inches less than in 1853.

The fall of water in rain and snow was 7·59 inches less than in 1853, and 6·96 inches less than the average fall in the preceding sixteen years; and it was 0·89 inches less than in any one of those years, 26·35 inches in 1849 being the least.

* I continue my observations at these hours for the easy comparison of the results, with the results of my former observations, extending back twenty years and made at the same hours. I also note in my journal the temperature at 7 A. M., and 2 and 9 P. M., which are the times adopted in the Smithsonian system of Meteorological Observations. The annual mean temperature deduced from these last observations, average about *three-fourths of one degree* higher than that derived from the former.

During the summer of 1854, this section of country is believed to have suffered more from drought than in any former season since its settlement, and the fall of water in the three summer months was never before known to be so small. The following table exhibits the amount of water which fell in those months in seventeen consecutive years.

Year.	June.	July.	Aug.	Total.
	Inches.	Inches.	Inches.	Inches.
1838	5·37	3·25	2·41	11·03
1839	2·70	6·26	1·91	11·87
1840	2·84	4·18	3·51	10·53
1841	5·16	2·87	1·40	9·43
1842	3·24	4·62	1·74	9·60
1843	4·58	2·59	2·09	9·26
1844	2·08	5·[illegible]5	3·46	11·39
1845	2·08	4·51	2·37	8·96
1846	3·63	5·08	0·48	9·19
1847	5·05	4·05	3·12	12·22
1848	2·19	3·57	4·40	10·16
1849	1·41	1·73	5·69	8·83
1850	3·18	5·08	0·89	9·15
1851	7·83	3·81	1·92	13·56
1852	4·76	4·99	1·50	11·25
1853	1·74	3·12	3·46	8·32
1854	2·88	1·60	0·61	05·9

By this table it will be seen that the amount of rain in the three summer months of 1854, was 3·23 inches less than in the same months in any one of the preceding sixteen years, and less than one-half the average for those months for the same period. During the continuance of the drought, fires prevailed extensively, destroying large quantities of lumber, growing timber, fences and buildings, and the atmosphere was, most of the time, densely filled with smoke. In consequence of the drought, the summer crops were greatly injured and that of potatoes nearly ruined.

The fall of snow in 1854, was seventy-eight inches, which was twelve inches less than in 1853 and twenty-five inches less than in 1852. Sleighs run, more or less, for three or four weeks, but the sleighing could hardly be said to be good at any time. The lake became entirely frozen over the 4th of February, was passable by teams the 6th in all directions. The passing became unsafe the middle of March—the ice was broken up the 10th of April, and the lake became clear and the steamers were out the 18th. The lake was highest May 10th, being then one foot four inches below extreme high-water mark, and was lowest September 1st, being seven feet five inches below high water, showing a change of level amounting to six feet one inch.

Robins and Bluebirds were seen March 12th, Song Sparrows the 15th. Red Plum in blossom May 16th, Cherry 18th, Pear 20th, Crab Apples 23d, Common Apple 25th.

The Aurora Borealis has occured less frequently than in some previous years. I find the following notes in my journal, but as my location is not favorably situated for observing the meteor near the northern horizon it may have occurred sometimes without being noticed.

January 23d, A beautiful low auroral arch in the N. E. from 8 to 10 P. M.; 28th, several ill defined arches in the N. about 8 P. M.; 29th, slight Aurora Borealis.

February 17th, Slight Aurora Borealis; 24th, a very bright aurora seen through various openings in the clouds; 27th, Auroral arch in the N., 10° high and well defined at 9 P. M.

March 16th, Auroral glow in the N. E.; 21st, Auroral arch about 8° high at 10 P. M.; 30th, a low arch of light in the N. E. at 9½ P. M.

April 15th, Auroral arch in the N. about 30° high at 9 P. M.; 19th, streamers in the N. reaching as high as the pole star, at 9 P. M.; 20th, a bright glow in the N. with streamers reaching up half way to the pole. 21st, A very fine exhibition of the aurora; at 9 P. M. a narrow belt extended from E. 8° S., overhead to N. 25° W. bending a litle south in the eastern part, with an average width of about 2½° and well defined. 23d, Another splendid aurora; at 8½ P. M. an arch extended from E. to N. W. bending S. through the zenith; at 9 the vertex of the arch had moved S. about 20°, while the ends of the arch had apparently remained stationary. There were in the mean time other bright arches in the N.; in these the flitting motions of the light were very conspicuous.

May 15th, An ill defined auroral arch in the N., 18° high—sky beneath it, nearly black; 19th, slight aurora.

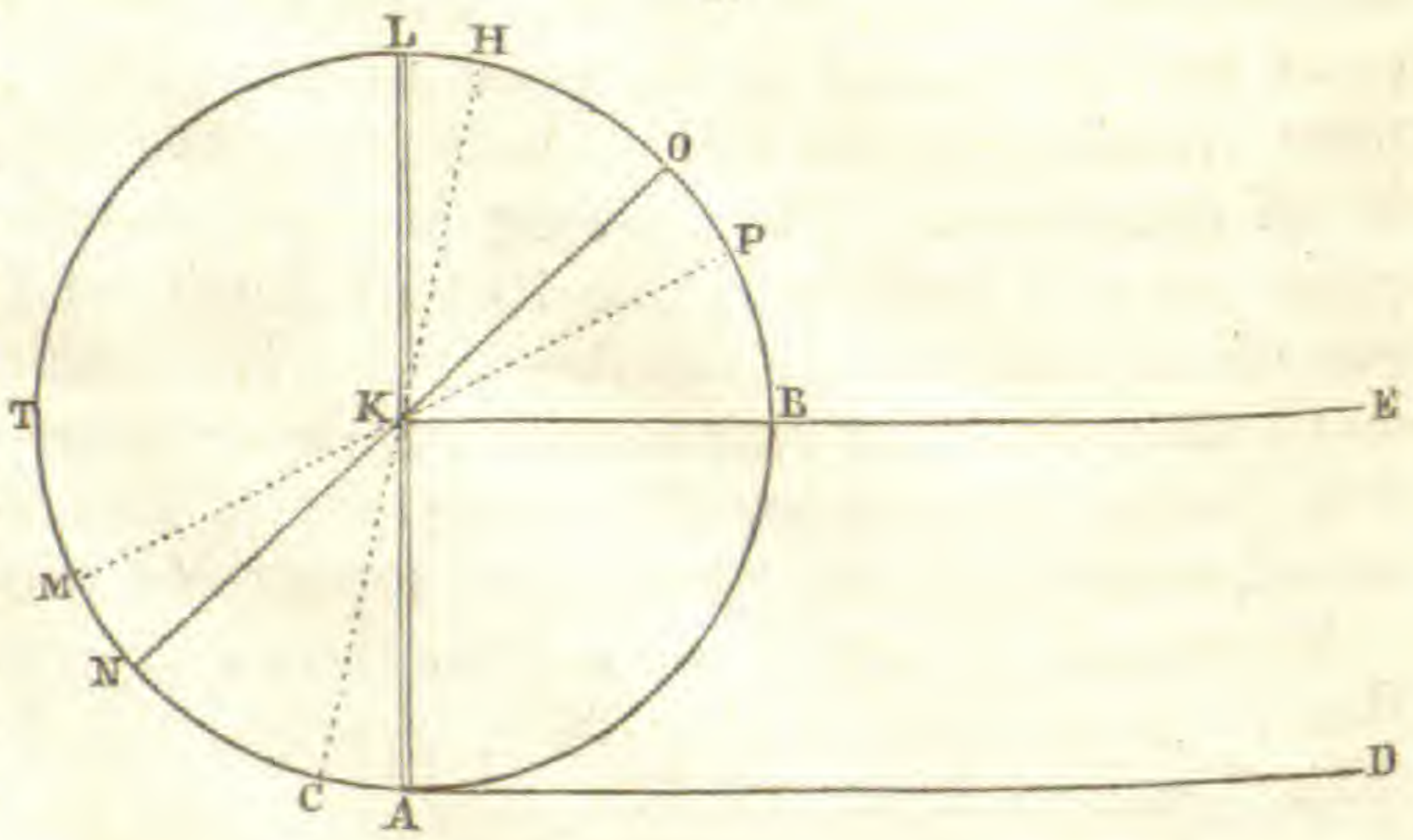
July 19th, Slight aurora in the N. W.; 27th, a low auroral arch in the N.

September 13th, Auroral arch quite low; 21st, slight auroral light; 26th, slight auroral light and several shooting stars.

By the foregoing notes, it will be seen that the aurora borealis was of very rare occurrence during the last half of the year, it having been observed only five times after the 19th of May, and not once in the last three months. During the entire year it was observed only twenty-one times. In former years its occurrence has been annually between thirty and forty times.

4. *Demonstration of the Theory of the Pendulum Experiment;* by Rev. J. L. Dagg.*—Let TABL, fig. 1, be a circular table, over the centre of which K, let a pendulum be suspended. If this pendulum be made to vibrate over any diameter of the table, it will continue to vibrate over the same as long as it continues to move; provided the table remains at rest, and the motion be undisturbed by any interfering cause.

1.



If all the parts of the table move, with equal velocity, in the same direction; if the point from which the pendulum is suspended, moves with the same velocity and in the same direction; and if the pendulum itself has the same motion, in addition to that by which it vibrates: then the relative positions of the pendulum and the table remain as before. The point of suspension will continue to be over the centre

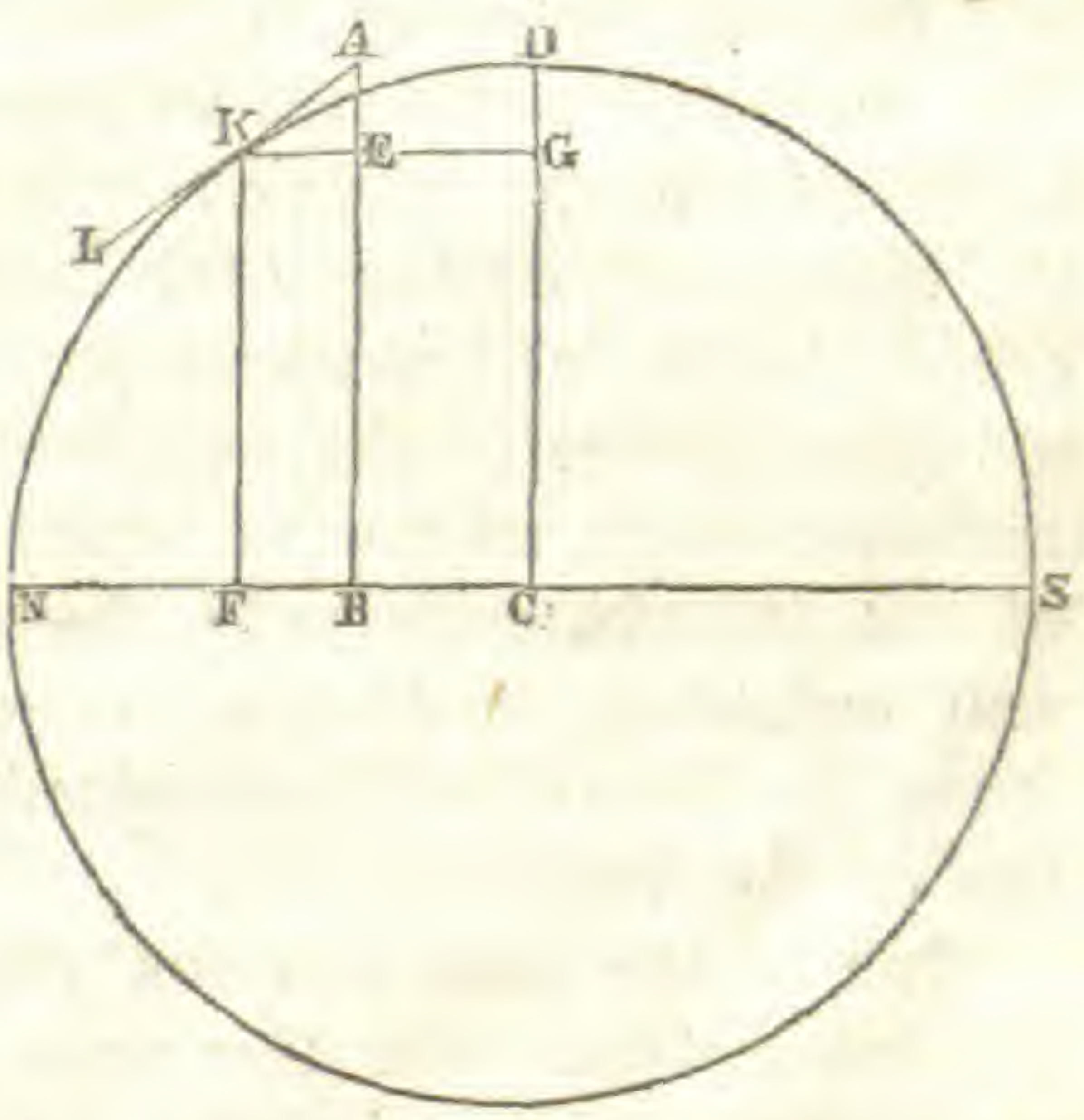
* During the month of June, 1851, while I was preparing to perform the pendulum experiment, at this place, the Rev. J. L. Dagg, President of our University, showed me a mathematical demonstration, by himself, of the principles involved in the experiment. It appears to me exceedingly simple and comprehensive; the annexed copy I have procured from Dr. Dagg, and, with his permission submit it for publication. Your Journal from time to time, has contained several excellent articles on the subject: yet a compact, geometrical demonstration, like the above, may be acceptable to many teachers, who have felt the need of a simple and concise form, in the instruction of classes. Yours truly, J. E. Willet.

Mercer University, Penfield, Geo.

of the table; and the pendulum will continue to vibrate over the same diameter as before.

Let us suppose that the pendulum, its point of suspension, and the centre of the table, are all moving as in the last case, with equal velocity, in the same direction, as towards E; but that the point A of the table, is moving in the same direction, that is towards D, with a greater velocity. In this case, the point A will leave the pendulum which was vibrating from A to L behind it; and the effect on their relative position will be the same as if the diameter over which the pendulum vibrated, receded from the position AL to the position CH. Since the table is a solid, the excess of velocity at A over that of the centre K, will tend to give to the whole mass a rotary motion around the centre. Hence, if another pendulum be supposed to vibrate from the same point of suspension, over any other diameter, as NO, its relative direction will change with the same angular velocity as the former; and the diameter over which it vibrates, will appear to recede from NO to MP.

2.



Let NDS, fig. 2, represent a meridian of the earth. Let the table, fig. 1, be supposed to touch this meridian at K. From the extremity A of its diameter, and from its centre K, let perpendiculars AB and KF be drawn to the earth's axis, NS.

It is manifest that the diurnal motion of the earth carries the point A around the earth's axis, with a greater velocity than the point K, since it describes a greater circle in the complete revolution. The excess of the velocity of A over that of K, will, as has been explained, cause a pendulum, vibrating over the diameter AL of the table to recede from the point A: and a pendulum, vibrating over any other diameter of the table, to change its relative direction, with the same angular velocity.

The velocity of A, is to the velocity of K, as the circumferences of the circles which they respectively describe; and these circumferences are as their radii AB and KF. Hence, velocity of A – velocity of K : velocity of K : : AB – KF = AE : KF. The velocity of K carries the point K in 24 hours, through a circle whose radius is KF. Hence it follows from the last proportion, that the velocity of A – the velocity of K would suffice to carry a point in 24 hours through a circle whose radius is AE. If AE were the radius of the circle in which the pendulum moves in receding from the point A, it would complete a revolution in 24 hours. But, in this motion, the pendulum in fact describes a circle around the point K, the radius of which is AK. Hence, 24 hours : time of revolution : : AE : AK. But the angle AKE is equal to the angle KCG (which is the latitude of the point K) each being the complement of CKG. Hence, AE : AK : : sine of the latitude : radius. We have therefore the following proportion,

Sine of latitude : radius : : 24 hours : time of revolution.

5. *On the distinctions supposed to limit the Vegetable and Animal Kingdoms;* by EDWIN LANKESTER, M.D., F.R.S, (Notices of meetings of the Roy. Ins., Mar. 24, 1854.)—In commencing, the Lecturer made some general remarks on classification, and pointed out the importance of accurate definitions in order to constitute the classes, families, genera, and species of the naturalist. The importance of defining species was greater than that of larger groups, because these were composed of species. As genera were collections of species, and families collections of genera, so the animal and vegetable kingdoms were but collections of species. The difficulty in distinguishing between the animal and vegetable kingdoms consisted in our imperfect knowledge of the characters of species which existed on what might be called the limits of the two kingdoms. The history of the attempts at defining animals and plants, for systematic purposes, would afford the best idea of the nature of these difficulties. The definition of Linnæus, that minerals grow, plants grow and live, animals grow, live, and feel, was first examined. In order to apply this definition, the terms growth, life, and feeling, required explanation. *Growth* simply indicated increase. The term *life* could not be defined in such a manner as to render it inapplicable to the physical phenomena of the inorganic world and at the same time embrace the lowest forms of organized beings. *Feeling* could not be defined so as to separate the movements evinced by so many members of the vegetable kingdom on the application of external stimulants, as the movements of the leaves of the sensitive plant, of the *Dionæa muscipula*, the stamens of the *barberry*, and the closing and unfolding of flowers, from those of the animal kingdom. Such were the distinctions attempted to be made by one who disregarded the use of the microscope.

One of the most obvious distinctions between the organic and inorganic kingdoms was the presence of the cell in the former. Under some circumstances it was not easy to detect the cell, as in certain fossils, and sometimes inorganic matters assumed a cellular form.

Another distinction adopted by naturalists, even since the general introduction of the microscope into natural history inquiries, was, that animals moved, whilst plants were fixed. This distinction, though applicable to the higher forms of plants and animals, was more than ever applicable to the organisms which required the microscope to detect their existence. Recent researches had shewn that the motile tissues in animals were composed of the same substance that was found to be present in the cells of all plants, and which under the names of nucleus, cytoblast, primordial utricle, and endoplast, had been recognised by all vegetable physiologists. This substance, composed of protein, was as actively motile in the plant as the animal. It was this substance which gave motility to the cells of *Protococcus*, the fibres of *Oscillaria*, the spores of various *Confervæ* and *Fungi*, and probably also to all other movements observed amongst plants.

When cilia were originally discovered as the agents of movement in infusoria, and upon the internal organs of higher animals, they were regarded as characteristic of animal life. These organs were now known to be present in the zoospores of various Confervæ, and were the active agents of movement in the *Volvox globator*, of whose vegetable nature there could be little doubt since the researches of Williamson and Busk.

The possession of what were called eye-spots in doubtful organisms had been brought forward to decide the animality of these beings. Such eye-spots were present as red points in certain stages of the growth of *Volvox*, and other undoubtedly vegetable organisms, and according to Henfrey, were due to the relation of the contents of the cell to light, and were in no way the agents of vision in the cells in which they are found.

The definition of Aristotle, that animals possessed a mouth, whilst plants had none, had been recently revived; and of all merely structural characters, it was the one best suited to the purpose of the uaturalist. Until recently the exceptions to this definition were numerous; but since the botanist had claimed so large a number of mouthless infusoria, as the *Diatomaceæ*, *Desmideæ*, and *Volvocineæ*, it was more than ever applicable. There were, however, certain exceptions; and these were found in the *Foraminifera*, the *Difflugiæ*, and other low organisms which had no permanent mouth. Some of these have the power of forming a temporary sac for the purposes of digestion.

Chemistry had from time to time offered its aid to the naturalist. At one time, the possession of *cellulose* by the vegetable kingdom was considered distinctive, and the ready application of iodine and sulphuric acid as the test of its presence rendered it an easily ascertainable diagnostic mark. It had, however, been recently detected by Smid in the Ascidian mollusca, by Thwaites in the Acaridæ, and by Virchow in the brain and spleen of man.

Another substance, *chlorophyll*, appeared at one time, to pronounce the presence of plants; but it had been found by Schulz in *Hydra*, *Turbellaria*, *Vortex*, *Mesostomum*, *Stentor*, *Bursaria* and other decidedly animal organisms.

Starch was another vegetable product, easily detected by iodine, whose universal presence in the plant seemed to offer the best practical chemical test; but Busk and other observers had recently detected this substance in the brain of man, and there was reason to suppose that starch might be very generally present in the animal kingdom.

It was thus seen that no one point in structure or chemical composition could furnish a means of distinction. A physiological point of much interest and importance had principally determined a certain number of botanists in claiming the *Diatomaceæ* and *Desmideæ* as plants. In certain Confervæ it had been observed, that previous to the production of the zoospore, two contiguous cells united, and each contributed its contents to form the germinating spore. This process was observed by Ralf and others in *Desmideæ*, and subsequently by Thwaites in the *Diatomaceæ*. In addition to this point these families exhibit other relations with the vegetable kingdom.

Whatever might be the difficulties presented in any individual case in the application of all or any of the before-mentioned distinctions, there was evidently a great antagonism or polarity exhibited by the animal and vegetable kingdoms when viewed as a whole. They were mutually dependent, attained the same ends in their growth and organization, but by contrary means. The great function of the animal tissues was the absorption of oxygen, and the disengagement of carbonic acid. The great function of the vegetable tissues was the absorption of carbonic acid and the disengagement of oxygen. The processes in the history of the life of the two kingdoms in which these distinctive functions appeared to be reversed, were not exceptions to the law, but were due to other agencies than those connected with the essential life of the plant or the animal. Thus carbonic acid was given out by plants at night, during fructification and germination. In the first instance, the gas given out was that which had been taken up during the day, and was not decomposed by the agency of light. In the latter instances a process of exudation took place in which the contents of the cells were undergoing change independent of the life of the plant. The germ during the growth of its cells absorbed carbonic acid and gave out oxygen, as in the growth of all other vegetable cells. The development of the carbonic acid arose from the decomposition of the starch and the sugar of the albumen of the seed. In the cases where animals had been found to give off oxygen, it was doubtful as to whether plants were not present or even mistaken for animalcules.

The composition of a series of vegetable and animal products was exhibited; and attention was drawn to the fact, that in all cases the vegetable compounds were formed from carbonic acid and water, or from carbonic acid, water, and ammonia, by the loss of oxygen. Acetic acid was referred to as an exceptional instance; but it was shewn that it was more probable, where acetic acid occurred as the result of vegetation, that it occurred as the result of deoxydation than of a process of fermentation in which alcohol was developed and subsequenty oxydised. An exception was also referred to in the animal kingdom in which fat is supposed to be formed by the deoxydation of sugar; but attention was drawn to the fact that this process admitted of another explanation, not opposed to the physiologico-chemical distinction pointed out.

These processes were further shewn to be connected with the relations existing between the animal and vegetable kingdoms. The plant was produced from mineral compounds—carbonic acid, water, and ammonia,—the substances out of which the animal was formed; and no instance was known of the animal appropriating and forming organic substances out of these compounds. This was the distinguishing feature of the life of the plant, and the liberation of oxygen gas its most constant result. The appropriation of substances thus formed, and the uniting them once more to oxygen gas, was the distinguishing feature of animal life, and the formation of carbonic acid gas its most constant result. Minor changes occurred; but these were the grand distinguishing features of the two kingdoms, the recognition of which by structure, function, or results could alone enable us to distinguish between plants and animals.

6. *Letter on the Smithsonian Institution*, by Prof. AGASSIZ, *addressed to the Hon. Charles W. Upham.—Dear Sir:*—Every scientific man in this country has been watching with intense interest the proceedings of the Smithsonian Institution ever since its foundation, satisfied, as all must be, that upon its prosperity the progress of science in America in a very great measure depends. The controver-

sies which have lately been carried on respecting the management of the institution have increased the solicitude of its friends with regard to its future prospects in a degree which can hardly be realized by those who are not immediately connected with the great cause of science.

As a foreigner, who has enjoyed but for a few years the privilege of adding his small share to support the powerful impulse which scientific investigations have lately received from those who are the native representatives of science in America, I have thus far abstained from taking any part in this discussion, for fear of being charged with meddling with matters in which I have no concern. There is, however, one feature of the institution itself, which may, I trust, justify the step I have taken in addressing you upon this subject as the chairman of the committee elected by the House of Representatives to investigate the proceedings of that establishment.

With the exception of a few indirect allusions, I do not see that any reference is made in the discussion now going on to the indisputable fact that the Smithsonian Institution is *not an American institution.* It was originated by the liberality of a high-minded English gentleman, intrusting his fortune to the United States to found in Washington an institution *to increase and diffuse knowledge among men.* America, in accepting the trust, has obtained the exclusive management of the most important and the most richly endowed scientific institution in the world; but it is at the same time responsible to the scientific world at large for the successful prosecution of the object of the trust, which is to *increase* and *diffuse* knowledge among men.

Were it not for this universal character of the institution, I would not think it becoming in me to offer any suggestion with regard to it. As it is, I feel a double interest in its prosperity—in the first place, as an institution destined to foster the progress of science at large, and without reference to nationalities or local interests, and next, as more immediately connected with the advancement of science in the country of my adoption.

The votaries of science may differ in their views about the best means of advancing science, according to the progress they have themselves made in its prosecution; but there is one standard of appreciation which cannot fail to guide rightly those who would form a candid opinion about it. I mean the lives of those who have most extensively contributed in enlarging the boundaries of knowledge.

There are two individuals who may, without qualification, be considered the most prominent scientific men of the nineteenth century—Cuvier and Humboldt. By what means have they given such powerful impulse to science? How have they succeeded not only in increasing the amount of knowledge of their age, but also in founding new branches of science? It is by their own publications and by aiding in the publications of others; by making large collections of specimens and other scientific apparatus, and not by the accumulation of large libraries. Humboldt never owned a book, *not even a copy of his own works*, as I know from his own lips. "He was too poor," he once said to me, "to secure a copy of them;" and all the works he receives constantly from his scientific friends are distributed by him to needy students.

Again, there is hardly a scientific man living on the continent of Europe, who is not indebted to him for some recommendations in the proper quarter for assistance in the publication of their works. I mention more particularly these details about Humboldt, because he is happily still among the living, and his testimony may be asked in a matter of such deep importance to the real progress of science. But the same is equally true of the part Cuvier took in his day in promoting science. All his efforts were constantly turned towards increasing the collection of the *Jardin des Plantes*, and supporting the publication of original researches, giving himself the example of the most untiring activity in publishing his own.

In this connection, I ought not to omit mentioning a circumstance to which the United States owes the legacy of Smithson, which I happen accidentally to know, and which is much to the point, in reference to the controversy concerning the management of the Smithsonian Institution.

Smithson had already made his will, and left his fortune to the Royal Society of London, when certain scientific papers were offered to that learned body for publication. Notwithstanding his efforts to have them published in their transactions, they were refused; upon which he changed his will and made his bequest to the United States. It would be easy to collect in London more minute information upon this occurrence, and should it appear desirable, I think I could put the committee in the way of learning all the circumstances. Nothing seems to me to indicate more plainly what were the testator's views respecting the best means of promoting science than this fact.

I will not deny the great importance of libraries, and no one has felt more keenly the want of an extensive scientific library than I have since I have been in the United States; but, after all, libraries are only tools of a secondary value to those who are really endowed by nature with the power of making original researches, and thus increasing knowledge among men. And though the absence or deficiency of libraries is nowhere so deeply felt as in America, the application of the funds of the Smithsonian Institution to the formation of a library, *beyond the requirements of the daily progress of science*, would only be, in my humble opinion, a perversion of the real object of the trust, inasmuch as it would tend to secure facilities only to the comparatively small number of American students who may have the time and means to visit Washington when they wish to consult a library. Such an application of the funds would in fact lessen the ability of the Smithsonian Institution to accomplish its great object, (which is declared by its founder to be the increase and diffusion of knowledge among men,) to the full extent to which they may be spent towards increasing unduly the library.

Moreover, American students have a just claim upon their own country for such local facilities as the accumulation of books affords.

If I am allowed, in conclusion, to state my personal impression respecting the management of the Institution thus far, I would only express my concurrence with the plan of active operations adopted by the Regents, which has led to the publication of a series of volumes, equal in scientific value to any production of the same kind issued by learned societies anywhere.

The distribution of the Smithsonian Contributions to Knowledge has already carried the name of the Institution to all parts of the civilized world, and conveyed with them such evidence of the intellectual activity of America as challenges everywhere admiration : a result which could hardly be obtained by applying the resources of the Institution to other purposes.

7. *On the So-called* "*Fountain of Blood*" *of Honduras;* by Dr. E. D. NORTH, (from a note to one of the Editors.)—It would seem that my friend, Mr. Ogden Rood, who is now in Germany, neglected to report to the Editors of the Journal the explanation obtained through the microscope of the brownish-red liquid from the "Fuente de Sangre" or Fountain of Blood, noticed in the Number for November last.

The brown liquid according to my examinations and also Mr. Rood's must be *a solution of the dung of Bats!* Nearly a year ago Mr. Rood left with me a few drachms of a reddish liquid, with a request that I should examine it and give him my opinion as to what it was. Being in haste, he gave me no account of the locality from which it was obtained, and indeed seemed to know nothing concerning the article, except that it was from some cavern. When I next saw him, he had himself examined the liquid and without having learned anything more of the locality and history of the sample had come precisely to the same conclusion as I myself had done. The liquid had evidently been copiously diluted, yet a drop confined by a bit of thin glass on a slide exhibited in as large number as could be expected in a substance excessively diluted with water, various of the harder and less destructible or digestible parts of insects, together with *perhaps* occasional fragments of small crustaceans. No memoranda were made and but few examinations, for the reason that the slightest and most cursory search revealed a sufficient number of such objects, and *no other remains whatever.* All that was necessary was to pass the whole of a single diffused drop through the field of view. Perhaps the branched spines of caterpillars which were quite common, in addition to the harder portions of legs, wings, corneæ, &c. indicated the excrement of birds as well as bats, for I do not know whether the latter take insects otherwise than in the air.

Since the notice of the "fountain" mentions that the cavern is frequented by "vast numbers of large bats (vampyres)" that "the liquid has the color, smell and taste of blood" (of course, we may make large allowance for exaggeration) and that "dogs eat it eagerly" we may conclude that the vampyres gorge themselves to that extent that, as is common with all animals overfed, much of their food passes without being digested. As to the statement that the "blood" is found "in a state of coagulation," a physiologist will withhold his belief until a careful examination is made by one who knows what the coagulation of blood really is. Evaporation and settling will reduce a solution of any dung to a semi-solid mass.

A suggestion is made that the character of the liquid may be due to Infusoriæ. Do even the unquestionably animal Infusoriæ ever cause by their death,—no matter how vast their numbers—a putrefactive and offensive fermentation? One of their offices when living being to counteract the effects of putrefaction, is it not a fact that they themselves are so organized or constituted, as not materially to corrupt the liquid in which they die?

8. *On a large Diamond from the district of Bogagem, Brazil;* by M. Dufrénoy, (L'Institut, No. 1096.)—M. Halphen has received recently from Brazil a diamond of remarkable dimensions, purity, and crystalline form. It has been called *l'Etoile du Sud.* It weighs 52·375 grammes, or 254½ carats. It will be reduced in cutting to about 127 carats. It is therefore among the four or five finest diamonds known. The Regent weighs 136 carats; the Kohinoor 120 to 122 carats; the Duke of Tuscany 139, the Great Mogul 279 carats, the Orlow, 195. It is perfectly limpid, and has the peculiar lustre which gives the diamond its highest value. The commercial value of the *Star of the South* has not been estimated. The Regent is estimated at six millions of francs. The form is a rhombic dodecahedron, having the edges bevelled and thus passing to a solid of 24 faces. The surface is unpolished and slightly chagrined, and shows some striæ corresponding to the octahedal cleavage. Its specific gravity is 3·529 at a temperature of 15 C.

On one of the faces there is a cavity, evidently due to an octahedral crystal implanted in it, as shown by its form and the octahedral striæ which it has copied. On another face there are two other cavities which were similarly formed by octahedral crystals. Moreover there is on this side a cleavage fracture, which I am disposed to believe was the point of attachment of this diamond to the gangue, from which it was apparently detached by alluvial causes. I also distinguish some black lamellæ which appear to be titaniferous iron, a mineral frequently found associated with quartz crystals in the Alps and Brazil.

It results from these facts that the *Star of the South* was originally one of a *group of diamond crystals*, analogous to a group of crystals of quartz and other minerals. The diamond therefore occurs in geodes in certain rocks as yet unknown, but which according to the observations of M. Lomonosoff belongs among the metamorphic rocks of Brazil.

The *Star of the South* was found near the close of July 1853, by a negress employed at the mines of Bogagem one of the districts of Minas-Geraes. It is the largest diamond yet brought from Brazil. This diamond will be exhibited at the Paris Exhibition of 1855.

9. *Observations of the Variable Star Algol wanted*, (from a letter addressed to the Editors, by B. A. Gould, dated Cambridge, 1855, Feb. 9.)—*My Dear Sirs:*—Professor Argelander has sent me a communication upon the variability of *Algol*, together with an ephemeris of the minima visible in America during the current year, and so full instructions concerning the proper method of observation, that it is within the power of any one, who can be sure of his time to within one minute and who will devote some little care to the process, to furnish by means of his unassisted eye, exceedingly valuable observations. The Astronomical Journal comes into the hands cf comparatively few, and professional astronomers furnished with valuable instruments feel it their duty to give themselves to such observations as cannot be made by those destitute of these facilities; and I venture therefore to indulge the belief that many lovers of science may through your Journal be induced to devote themselves to the labor of attaining additional facts for the study of this singular and interesting phenomenon. You will therefore pardon me for asking your aid in calling the attention of your

large circle of readers to the subject and requesting all who are interested in the progress of astronomy and can spend the time for observation, to do their part in contributing to the materials available for investigating this variability—which is one of the most remarkable of all the unexplained phenomena of Sidereal Astronomy.

NOTE.—Dr. Gould desires us to state that he will send to any observer who may request it, a copy of the No. of the Astronomical Journal, (1855, Jan. 31,) which contains Prof. Argelander's communication. We propose to copy it in our May Number.—EDS.

10. *Discovery of Gold in Australia.*—The first discovery of Australian gold belongs to the Rev. W. B. Clarke, who has long been engaged in Geological researches in New South Wales. The following letters addresed to Mr. Clarke are part of the evidence taken before a government committee on this question.

From R. Therry, Esq., one of Her Majesty's Judges of the Supreme Court, dated Keera Vale, Wollongong, October 2, 1852.—*My Dear Sir*,—" I can have no hesitation in stating, I quite well recollect the circumstance of your communicating to me your discovery of gold. The conversation took place on board the Paramatta steamer some time in 1844 on my return to Sydney from a visit to a part of the country which I then represented in the Legislative Council. On that occasion you showed a piece of quartz in which two or three large specks of gold shone very distinctly and brilliantly ; and you intimated that from that and other specimens you had seen, and from the geological observations you had made, you were confident that gold would be found in abundance in this colony. I mentioned the matter to many of my friends at the time, and the recent extensive discoveries of gold brought very vividly to my recollection your predictions which these discoveries have verified.

I therefore, can have no objection to the mention of my name in the manner in which you have introduced it in your evidence."

From James Macarthur, Esq., M.L.C., who was Chairman of the Gold Committee on 24th September, 1852, *dated Camden Park, Camden, 29th July*, 1854.—*My Dear Sir*,—" I have deferred answering your note in order to refresh my memory by a reference to memoranda connected with public transactions, which I know took place at the period of our conversation, relative to your *first* discovery of gold in the Hartley District, and your conviction, from *geological* investigations, that Australia would prove to be a great *gold*-producing country. I find, upon reference to those memoranda, that your communications to me, on the above subjects, must have been in 1843 and the early part of 1844. I well recollect that you pointedly alluded to the grave objection to opening gold mines to the cupidity of a population which at that time constituted the great majority of the inhabitants of these colonies, and you mentioned the strong views entertained by Sir George Gipps as to the ill consequences to be dreaded from a disclosure of what you had ascertained." * * * *

11. *Stereoscopes.*—The great beauty and perfection of photographic views in a stereoscope have given great and deserved popularity to this new instrument. We have recently received a form of it from J. F. Mascher of Philadelphia (No. 408 North 2nd st.), which is exceedingly

convenient, and effective. It is hardly larger than a common daguerreotype case and has all its compactness and simplicity, and requires but a single trial to be fully understood and appreciated. The views accompanying it are excellent, and those on glass especially are wonderfully life-like. A view of the Suspension Bridge at Niagara for example, has in effect all the length and depth and sublimity of the natural scene. Another of Mount Vernon transports you instantly to the place, and the trees seem to stand around you and almost overhang your head—the only deficiency is that the leaves are motionless. Views of statuary, as is well known, present most admirably the effect of the real statue. There is no reason why the complete galleries of Florence, Rome and other cities should not be on exhibition in this and other countries. Mr. Mascher makes these instruments of a great variety of forms, besides the simple one here alluded to.

12. *Heights of Perpetual Snow in the Alps.*—M. Roret has deduced from observations during the years 1851, 1853 and 1854 in the French Alps that the height of perpetual snow is 3400 meters, or 700 meters above the height stated in many works on physics and meteorology.—*L'Institut*, No 1093.

13. *Hail at Cuba.*—Hail is of very rare occurrence in Cuba, and the neighboring islands. According to M. Poey no hail fell at Havana from 1784 to 1825, an interval of 40 years. Between 1825 and 1828 there were two years without hail. There were also 17 years from 1828 to 1846 without hail; but from 1846 to 1849, there were four cases of hail, three of which occurred in the same year, 1849, one in March, two in August. There was none in 1850.—*L'Institut*, No. 1092.

14. *Gold near Reading, Pa.*—Dr. C. M. WETHERILL has confirmed his former announcement of the discovery of gold near Reading. The gold was discovered by Mr. Philipps, a mining geologist, searching for iron ore, a few miles westward from Reading and on the farm of Mr. Entlich, also on the western slope of Penn's Mount. It was obtained in washing specimens of ferruginous quartz.

15. *On the Mountain Systems of America.*—M. J. MARCOU presented a paper on this subject to the Academy of Sciences, Paris, Dec. 26, 1854.—*L'Institut*, No 1096.

16. OBITUARY.—*Professor Edward Forbes*, (Ath., Nov. 25, 1854.)—Professor EDWARD FORBES was born at Douglas, in the Isle of Man, and received there his early education. When very young he acquired a taste for natural history; but, evincing talent for drawing, he was induced to commence his studies as an artist, and, with this object in view, he attended for six months the studio of the late Mr. Sasse in London. In after life, in his travels and natural history studies, he felt the advantage of this short training. His love, however, of natural history led him to the medical profession, as affording him a wider field for his favorite pursuit. He accordingly repaired to Edinburgh, where he commenced his career as a medical student in 1830. Although he pursued his medical studies with great zeal and success, he never presented himself for his degree at the University. He had, in fact, contracted so strong an attachment for the sciences of zoology and botany,

that he determined to devote himself to a scientific career. Whilst a student, plants and animals seemed equally to attract his attention. It was, however, in a knowledge of the lower forms of the latter,—the Mollusca and Radiata,—that he was most distinguished. Whilst still a student at Edinburgh, he had an opportunity of making a voyage in the Mediterranean, and visiting the coast of Algiers, and one of his earliest published papers was 'On the Land and Fresh-water Mollusca of Algiers and Bougia.' About this time he also visited the continent of Europe, resided for some time in Paris, and made a tour in Norway. During this time he was active in the pursuit of natural history, and he published several papers giving the result of his observations. Among these may be mentioned, 'Notes of a Natural History Tour in Norway', 'On the Comparative Elevation of Testacea in the Alps,' and 'Malacologia Monense: a Catalogue of the Mollusca inhabiting the Isle of Man and the neighboring Sea.'

Whilst a student in Edinburgh he acquired a remarkable ascendancy over the minds of his fellow students,—and many of his contemporaries, who have since pursued a successful career of natural history study, have traced it to his influence. This power of drawing men under his influence increased with his years; and, perhaps, few men of his age have produced so permanent an effect on the minds with which he came in contact. It was in Edinburgh that he may be said to have invented the art of dredging, for till his time it had scarcely been regarded as a part of the serious work of the naturalist. He drew attention to the important results that could be obtained by the use of this simple instrument, which had been only employed by fishermen to procure shell-fish. His numerous papers at this time 'On the Structure and Forms of the Marine Invertebrata' attested the value of the dredge, and with it he may be said to have opened a new field of research, if not a new branch of science. It was, afterwards, with this instrument, in the Ægean Sea, that he made the important observations by which he was enabled to point out the great law, that as there were zones of animal and vegetable life in altitude on the sides of the mountains that covered the earth, so there were zones of animal and vegetable life in depth on the sides of the valleys of the ocean.

Frequent records of his dredging excursions are to be found in the pages of the *Magazine of Zoology and Botany;* and through his influence Dredging Committees have been appointed by the British Association,—whose labors have greatly contributed to enlarge our knowledge of the inhabitants of the British seas. One of the earliest and most important of his systematic works was the result of his dredging labors. This was his 'History of British Star-fishes and other Animals of the Class Echinodermata,' published in 1841. In this work he displayed a minute and comprehensive knowledge of the class of animals to which it was devoted,—and added not only many species new to the British Fauna, but many species were here described for the first time. Though on a subject far removed from ordinary human sympathy, he gave it a wide interest by lively descriptions, pretty vignettes and quaint tail-pieces, all from his own pencil.

When, subsequently, he became a geologist, and one taking rank with the most distinguished, it was his practical acquaintance with the bed of the ocean, which he had acquired by means of the dredge, that gave his opinions weight, and which enabled him to determine points in the age and relationship of the strata of the earth that had hitherto been unsolved problems.

In 1841 Mr. Forbes obtained the appointment of Naturalist to H. M. Surveying Ship Beacon, which was commissioned to bring from Lycia the marbles brought to light by Sir Charles Fellows. In the spring of 1842 he was occupied with the Rev. Mr. Daniell and Lieut. Spratt in examining the coast and country of Lycia. In this journey Mr. Daniell fell a victim to the fever of the country, and Mr. Forbes had an attack, the effects of which he occasionally felt till within a short period of his decease. An account of their joint labors,—which resulted in the discovery of the sites of eighteen ancient cities,—was afterwards published by Messrs. Spratt and Forbes in their 'Travels in Lycia.' It was during this voyage that Mr. Forbes prosecuted his researches with the dredge in the Ægean, which resulted in the enunciation of the law for the development of animal and vegetable life in the depths of the ocean. The results of these researches were first made known in a 'Report on the Mollusca and Radiata of the Ægean Sea, and on their distribution, considered as bearing on Geology,' made to the British Association, at their meeting at Cork, in 1843.

During his absence on this voyage, the chair of Botany at King's College, London, became vacant by the death of the late Mr. David Don. Although his later published papers had been on zoology, Mr. Forbes had devoted much attention to botany, and was known for applying the same acumen to the study of plants and their distribution as he had now become so distinguished for in relation to the lower forms of animals. He was the successful candidate for this chair, which he filled with great success till his recent appointment to the chair of Natural History at Edinburgh. Those who attended his class will ever remember the charm he threw around the study of Vegetable Structure and the delightful hours they spent in his company during the periodical excursions, which he made a point of taking with his pupils, in the neighborhood of London. Nor were these excursions attended by pupils alone. Many are the distinguished men of science in London who sought this opportunity of availing themselves of his great practical knowledge of every department of natural history. It was during the delivery of his first course of lectures 'On Botany' that he worked out the interesting relations that exist between the morphology of the reproductive system of the Sertularian Zoophytes and its analogy with that of flowering plants. His paper on this subject was read at the British Association, at York, in 1844.

He now also obtained the appointment of Librarian and Curator to the Geological Society. He occupied this position till his appointment to the Palæontological Department of the Museum of Economic Geology in 1846.

Although the chief part of his time was now occupied in the practical details of palæontology, he still found leisure to arrange some of the vast mass of original matter which he had collected during his dredging excursions. In 1848 he wrote for the Ray Society a 'Monograph on the British Naked-eye Medusæ.' This work was beautifully illustrated from drawings made by himself. It was characterized by the same extensive research and accuracy of detail that distinguished his 'History of Starfishes,'—and is one of the most important contributions ever made to this department of natural-history literature. No sooner was this work published than we find him engaging, in conjunction with Mr. Henley, in the publication of a 'History of British Mollusca.' This work was completed, in four volumes, in 1853.

It was not long after his connection with the Geological Society and Museum of Practical Geology, that the fruits of his closer acquaintance with the facts of geology became apparent. One of the most remarkable contributions to the science of geology in this country appeared in the first volume of the 'Memoirs of the Geological Survey of Great Britain.' This paper, which may be regarded as a work on the subject, is entitled 'On the Connection between the Distribution of the existing Fauna and Flora of the British Isles, and the Geological Changes which have affected their area.' In this work the happy combination of great botanical and zoological knowledge is made to bear on some of the most intricate inquiries with regard to the age and relationship of the rocks of Great Britain. From this time the Transaction of the Geological Survey, and the 'Journal of the Geological Society,' were enriched with his papers, all displaying accurate and extensive observation, combined with profound and original thought. Turning to the list of his papers and works on Zoology and Geology, in the 'Bibliography,' published by the Ray Society, we find them amounting to eighty-nine. This list does not comprise his 'Botanical Papers,' or those published since 1850, which together are very numerous. But whilst thus engaged in severe scientific toil, he found time to engage in lighter literary occupations,—contributing to more than one periodical. We will not speak of his contributions to the *Athenæum*, though they were many and valuable. His article on 'Shellfishes, their Ways and Works,' in the first number of the new series of the *Westminster Review*, is a gem in its way; and the brilliant article on 'Siluria,' in the last number of the *Quarterly*, was from his pen. At the time of his death he was engaged on several works. The one which he early announced, under the title of 'Rambles of a Naturalist,' he still intended to complete. Another, the 'Zoology of the European Seas,' is nearly all printed. He was also preparing for publication the results of his researches in the Ægean.

Young as he was, such a man had earned the highest honors that natural history science could confer, and to the honor of those with whom he associated, they were not slow to discern and reward his merits. In 1852, he was elected President of the Geological Society, and sat in the chair which had been filled by Prof. Sedgwick, Sir Roderick I. Murchison and Sir Charles Lyell, who bore willing testimony to the genius of their youthful successor. In 1854, he was appointed President of the Geological Section of the British Association. He was early elected a Fellow of the Royal Society, and appointed a member of its Council.

When the illness of Prof. Jameson rendered it necessary that a successor should be appointed, all interested in the prosperity of the University of Edinburgh looked to Prof. Forbes as his successor. He obtained this appointment in 1853. He was enthusiastically welcomed by professors and students to his *Alma Mater*. He was proud of having attained the position which, as a student, he had hoped one day to fill. He lived to complete but one course of his lectures. But though he is gone, his spirit survives in his works, and these will ever form an important part of the history of natural science during the present century.

He was buried on Thursday last: the town council and professors of the University and students following his remains to the grave.

17. *Faraday's Lectures*, (The subject matter of six lectures on the Non-metallic Elements, delivered before the members of the Royal Institution in the spring and summer of 1852.) 12mo. pp. 293. *London*, Longmans, 1853.—This interesting little volume has apparently escaped general attention in this country, not having been republished. Like everything emanating from the same source it is marked by originality, clearness and the broad philosophical spirit in which the several topics, apparently so trite,—are handled. It abounds in every lecture with highly suggestive remarks on the general tendencies of chemical philosophy and especially as this science receives new light from the late recent advance of our ideas respecting the subject of Allotropism. The topics are treated in the following order: Lecture 1st, Oxygen (and ozone); 2nd, Chlorine, Bromine and Iodine; 3d, Hydrogen; 4th, Nitrogen (including ammonia and respiration); 5th, Sulphur and Phosphorus; 6th, Carbon. Each lecture is preceded by an introduction rehearsing the well established elementary facts bearing on the subject of the lecture; and in a general introduction, the history of the science is reviewed in a graphic manner with reference to tracing the golden thread of system and philosophy from its origin to the present time. Every teacher will read these lectures by Prof. Faraday with a high relish sharpened by curiosity to see how the first of living chemical philosophers in England, will handle the plainest topics of elementary chemistry, without becoming either tedious or trite. The various facts relating to the history of Ozone are very fully discussed, and Faraday gives full acceptance to the facts and observations of Schönbein on this subject. Such an unqualified admission of these facts accompanied by interesting generalizations founded on them from so high an authority, must serve to strengthen the faith of doubtful disciples. The proof-reader has been sadly negligent of his task in the editing of this volume otherwise so creditable to Mr. J. Scoffern, M.B., late Professor of Chemistry at Aldersgate College, who was permitted the use of the author's notes in preparing these lectures for the press. Most of the errors alluded to are such as the reader at once detects, as *properly* for *propriety* (p. 49), *an acid*, for *acids* (p. 93), *marked* for *masked* (p. 85), *found* for *burned* (p. 233), &c. But the use of *sulphur* for *sodium* (p. 149, last line), 100 for 80 (p. 84), and similar errors of fact may embarrass the young chemical reader. In that fine experiment illustrating the production of ammonia by the action of spongy platina, on a mixture of *five* vols. of hydrogen with two of binoxyd of nitrogen, the reader is told to mix *one* volume of hydrogen with two of nitrogen (p. 214). Dr. Hare is, if we remember correctly, entitled to the credit of

devising this most satisfactory of all modes of showing the production of ammonia from purely inorganic materials, a fact which Prof. Brande in his lectures on Organic Chemistry applied to the Arts, takes care to mention. An error on page 292 respecting the number of gases that have been solidified, which is corrected in the errata, occurs again on page 79, where we are told that "one gas (carbonic acid) has been condensed—into a solid." Such an editorial error is particularly unfortunate in reporting the lectures of a philosopher who has himself reduced *nine* of the gases to the solid state. Abating these and similar blemishes, we have perused this little volume with the highest satisfaction.

18 *Professor Brande's Ten Lectures* on some of the Arts connected with ORGANIC CHEMISTRY, were delivered also before the Royal Institution, subsequent to those by Prof. Faraday, just noticed, and are reported also by Mr. Scoffern. The subjects discussed are, Lecture 1st, Dyeing,—preceded by an Introduction on the History of textile materials to which dye-stuffs are Applied—2d, On the Operations involved in Bleaching—3d, On Calico Printing—4th, on Gelatine, Tannic and Gallic acids and their applications,—5th, On Sugar and its manufacture with an Introduction on the general and natural history of Sugar—6th, on Woody fibre—7th, on the Chemistry of fatty bodies involving the manufacture of Soaps and Candles: with an Appendix on the collateral influences of the Discoveries of M. Chevreul—8th, On hydrocarbons—9th, on Nitrogenous or Azotized Substances—10th, On the phenomena and products of Fermentation. A glance at these topics will satisfy the reader that the ten Lectures here reported must have possessed uncommon interest coming from a source so abundantly experienced in the Chemical Arts as Prof. Brande. The reports are however so much condensed as to present few new facts to the scientific reader, but notwithstanding this unavoidable defect in a popular performance, the labor of Mr. Scoffern in giving us so good a report of Prof. Brande's lectures will be warmly appreciated.

19. *Outlines of Chemical Analysis, prepared for the Chemical Laboratory at Giessen;* by HEINRICH WILL, Professor of Experimental Chemistry in the University at Giessen. (Translated from the third German edition by Daniel Breed, M.D., and Lewis H. Steiner, M.A., M.D.) Boston and Cambridge: James Munroe & Co., 1853. pp. 279, 8vo.—Dr. Will's "Outlines" is a book too well known to all Chemical teachers and students to require more than the simple announcement of a new translation by Drs. Breed and Steiner from the third (last) German edition. Those who remember only the first edition will find little in the general appearance of the present portly volume to remind them of the thin 12mo of former years. Chemical science has made great progress in the last ten years, and Dr. Will has not been slow in keeping his book up to the times. This work fills an important place among chemical text-books, being much more useful to the young student than the voluminous treatise of Rose, while it is sufficienly full to meet most of the wants of the more advanced student. We have not had an opportunity of proving the accuracy of the present edition from actual use, but it has every guarantee for this important quality.

20. *The Native Races of the Russian Empire;* by R. G. LATHAM, M.D., F.R.S., &c., with a large colored map and other illustrations.

London and New York: H. Baillière, 1854. 12mo, pp. 340.—This is a most timely contribution to the small amount of real knowledge possessed by even intelligent foreigners of the many various races which make up the population of Russia. The great interest universally felt at this moment in everything relating to the vast empire of Russia, will render this descriptive account of the tribes occupying its surface, and including all those nations who have been conquered by the ruling race or absorbed into its body—particularly acceptable. The volume is accompanied by a reduced copy of the great Ethnological and Statistical Map of Russia which was published in 1852 by the Imperial Geographical Society of St. Petersburg.

The author recognises three chief constituent stocks in the Russian Empire, viz., the Ugrian, the Turk and the Sarmatian. These original races are now subdivided into no less than thirty-eight tribes each distinguished on the map by a separate color.

Dr. Latham is beyond doubt the leading authority in our language on all ethnological topics, and his present compendious little volume will be caught up with avidity by thousands who would have hesitated to grapple with a more extended work, while the amount of new facts and new summaries of old facts is such as to reward the perusal of all.

F. Engel: Axonometrical Projections of the most important geometrical surfaces and drawings for descriptive geometry, with IX plates and a catalogue of models for the study of Optics and the higher branches of Geometry. Price $3.50. [The models in wood or plaster can be had at 343 Broadway, the Depot of J. B. Luhme & Co., of Berlin.]

British Association: Proceedings for 1853. *London*, 1854.

S. S. Garrigues: Chemical Investigations on Radix Ginseng Americana, Oleum Chenopodii Anthelmintici, and Oleum Menthæ viridis. Inaugural Dissertation. 24 pp. 8vo. *Göttingen*, 1854.

Proceedings of the Acad. Nat. Sci. Philadelphia, Vol. VII, No. 6.—p. 196, Characteristics of some of the Cartilaginous fishes of the Pacific Coast of North America; *C. Girard.*—p. 197, Abstract of a Report to Lieut. Jas. M. Gilliss, U. S. N., on the Fishes collected during the U. S. N. Astronomical Expedition to Chili, *C. Girard.*—p. 199, Fossil bones from the banks of the Ohio, Indiana; *J. Leidy.*—p. 203, Loxia leucoptera abundant near Philadelphia; *J. Cassin.*—p. 204, Abstract of Experiments on the Physical Influences exerted by living Organic and Inorganic membranes upon Chemical Substances passing through them by Endosmosis; *J. Jones.*—p. 209, On the question of the identity of Bootherium cavifrons with Ovibos moschatus; *J. Leidy.*—p. 211, Descriptions of the Species of Trox and Omorgus inhabiting the United States; *J. L. LeConte.*—p. 216, Some corrections in the Nomenclature of Coleoptera found in the United States; *J. L. LeConte.*—p. 220, Descriptions of new Coleoptera, collected by T. H. Webb, M.D., in the years 1850, '51, '52, while Secretary to the U. S. Mexican Boundary Commission; *J. L. LeConte.*—p. 226, Abstract of a Report to Lieut. J. M. Gilliss, U. S. N., on the Reptiles, collected during the U. S. N. Astronomical Expedition to Chili; *C. Girard.*—p. 227, A List of Pigeons of the Genus Carpophaga, in the Academy of Nat. Sci. Philadelphia, and of the U. S. Exp. Exped. (Vincennes and Peacock,) Washington; *J. Cassin.*—p. 232, Herrerite identical with Smithsonite; *F. A. Genth.*—Chemical Notices; *C. M. Wetherill.*—p. 236, Rectification of Mr. T. A. Conrad's Synopsis of the Family of Naiades of North America, published in the Proc. Acad. Nat. Sci. Philad. for Feb. 1853; *I. Lea.*

Proceedings of Acad. Nat. Sci., San Francisco.—p. 7, New Fishes of the Genus Sebastes; Centrarchus; Morrhua, Grystes lineatus, Clypeocottus robustus = Aspicottus bison of Girard; Brosmius marginatus *A.;* Syngnathus griseo-lineatus *A.;* Accipenser acutirostris *A.*, A. brachyrhynchus *A.;* Osmerus elongatus *A.*, Mustelus felis *A.*, Catostomus occidentalis *A.*, Gila grandis *A.*,—all by *W. O. Ayres*, pages 7 to 18 all that we have received of the Proceedings.—p. 14, Description of Lavatera assurgentiflora (n. sp.); *Dr. Kellogg.*

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C. A. KOCH'S Verlagsbuchhandlung; Th. Kunike, Greisswald,—

Dr. ALBERT HOEFER: Zeitschrift für die Wissenschaft der Sprache; 4th vol. 2nd Heft. *Greisswald*, 1854.

A. H. BAIER—Symbolik der christlichen Confessionen und Religions-partheien. Erster Band: Symbolik der römisch-katholische Kirche; zweite Abtheilung, Der römische Katholicismus in der Organisation seiner besonderen Sphären.

J. G. L. KOSEGARTEN, Theologiæ et Literarum Orientalium in Academia Pomerana Professore: Carmina Hudsailitarum quotquot in codice Lugdunense insunt, Arabice edita adiectaque Translatione Adnotationibusque illustrata. Vol. I. Sumtu Societatis Anglicæ quæ Oriental Translation Fund nuncupatur. 1854.

G. P. PUTNAM has recently published Journey to Central Africa, by BAYARD TAYLOR, 522 pp. 8vo, with maps and plates.

The Land of the Saracens, by BAYARD TAYLOR, 452 pp. 8vo.

Mr. Rutherford's Children, Vol. II. By the author of "The Wide Wide World."

The next No. of this Journal will be published on the first of May.

CONTENTS.

(*For remainder of Contents, see third page of Cover.*)

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THE

AMERICAN

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[SECOND SERIES.]

ART. XXXI.—*The Vegetable Individual, in its relation to Species*, (Das Individuum der Pflanze in seinem Verhältniss zur Species,—Generationsfolge, Generationswechsel und Generationstheilung der Pflanze); by Dr. ALEXANDER BRAUN, Professor of Botany in the University of Berlin, &c. &c. Berlin, 1853.* Translated by CHAS. FRANCIS STONE.

PART I.—INTRODUCTION AND HISTORY.†

IN Organic Nature the two principal phenomena, in which the shifting scenes of Life are unfolded, are individual development and individual propagation. Through them the intricate course of Nature, and its living chain of organized beings, are refreshed and renewed. Every new generation seems to bring back the old form; still, to the investigator who looks deeper into the graves of the past, a slow, but certain, progress reveals itself even in this apparently identical succession. If nature is to be for us something more than a labyrinth of varied and intricate phenomena; and if, in the apparent disorder, the hidden threads of the connection are to become visible, we must first of all separate and compare the different spheres of life, placing them higher or lower, according to their rank. The starting-points, which nature offers for such a purpose are, the *Individual* and the *Species*; whose reciprocal relations, however simple they may at first appear, when followed out to particulars lead to difficulties which

* From the Transactions of the Royal Prussian Academy of Sciences, for 1853.

† I have omitted the author's brief introductory remarks.—*Transl.*

demand an accurate examination.* From the Botanist such an examination is particularly demanded; as the vegetable ideal presented to us by the science in its earlier stages has been obscured by conceptions obtained from the animal kingdom having been transferred to Botany, though based upon the mistaken assumption that plants possess the same independent individuality as animals, the same organs with equally well-defined functions, and the same mutually dependent relations of the vital activities. And the investigations of late years, forsaking the old views more and more, have arrived at no well-defined conclusions, and, particularly as regards vegetable individuality, seem to lead more to negative than to positive results. After all, this should not surprise us; for even a superficial investigation shows relations in plants which will hardly harmonize with the common conceptions of individuality, and which require a careful review.

In the whole realm of organic nature, we know of not a single species of which any one individual is a perfect representative: on the contrary we see each species adding generation to generation, by multiplying the individuals in time and space, until its day has ended, whether from internal or external causes. In this particular, the species resembles the individual itself; having its allotted age, though measured by days of a higher order, and its appointed cycle of life,—in which the individuals appear as members occupying a certain time and place,—resembling the successive relative forms through which the individual passes. For the organic individual does not manifest itself in one single permanent form, but in a succession of forms, now gradually connected, now broadly interrupted; and these last, especially in plants, may attain to an independence, which gives them the character of a subordinate species. To this analogy between individuals and species it may be objected, that, in most cases, a very remarkable metamorphosis is connected with the successive forms of the individual, while within the sphere of the species the consecutive members continue to have essentially the same

* Should any one be inclined to doubt that the nature of the vegetable individual needs a futher discussion, I would beg him to turn to the latest works on Botany and compare the passages which treat of the plant's individuality. I take *Kützing's Grundzüge der phil. Botanik* (2nd Part), as we have a right to demand from a work that lays claim to philosophical development, a fundamental discussion of this subject, since it is the ground-work of the whole science. The first two paragraphs under the heading "*Das Pflanzenindividuum als Organismus*," read as follows: "By individual we here mean a single vegetable body not organically connected with a similar vegetable body. Vegetable individuals have the power of developing the general phenomena of vegetable life by themselves, unassisted by any other individual of the same species. It is the nature of an organism to consist of members. . . . The possession of members is the first, as well as the most essential condition of the existence of the vegetable individual." Not one of these assertions is true of vegetable individuals, either in the broader or the narrower signification of the term. To say nothing of the connection, in which the individuals appear which are successively developed by shoot-formation, the coalesence of stocks which were originally sepa-

character.* But, however important this fact may be, still we may assert of the individual as well as of the species, that it completes the cycle of its existence in a succession of subordinate generations, while, on the other hand, we may affirm of the species, that like the individual, it exhibits a determinate cycle of development.† In comparing the processes of propagation with the process of the formation of the individual, cell-formation, which lies at the foundation of both, reveals the intimate connection which exists between the small and the great spheres of development; while the numerous cases which admit of a double explanation (since they may be ascribed with almost equal justice to the inferior cycle of development of the individual, or to the superior one of the species) establish the close relationship of both. The above-mentioned circumstance, that the cycle of development does not present as graduated a progress in the species as it does in the individual, seems to suggest that the most reliable view of the analogy between the species and the individual is that in which the species is not compared with the whole cycle of the individual's successive development, but with the *single steps* of the metamorphosis (which of course has its own subordinate members), and in which the species itself is regarded as an inferior "momentum" of a still more comprehensive cycle of development; but to determine this would lead us too far from our subject.‡ In a word, the relation of the individual to the species is that of an inferior cycle of development to a superior: the individual is a *member* of the species. However, although they are under one and the same specific law, all the members of the species are not identical: a single member only represents the idea of the species more or less incompletely; and certain members, or series of members, are thus reciprocal complements. The regular relations here brought to view will form the principal subject of the present investigation. But we must first carefully determine the sphere of the individual. The individual shall not and may not be considered by itself: it must be viewed

rate is no rarity. Are the pines of a pine-forest no individuals because, as Göppert has shown, they are connected with each other by their roots? Do the filaments of *Zygnemæ* cease to be individuals when they copulate. Are the cells of *Hydrodictyon* and *Pediastrum*, originally separate, no longer individuals when they have joined themselves into a net, or a star? To refute the second assertion, we may refer to diœcious plants; to refute the third, we refer to the one-celled Algæ and Fungi, a part of which, at least, are of such a character that we can by no means ascribe to them an *organisation* in the usual acceptation of the term. However, we may regard it as an improvement, that *Kützing's Grundzüge* treats of the vegetable individual at all; for the earlier manuals do not even mention this important subject, but commence their account of plants with descriptions of the root, stem and other organs, or, as it has been preferred of late years, of the cells and vesicles.

* Those of the forms and properties, which persist through the successive generations, determine the species. *Link: Grundlehren der Kräuterkunde*, vi, p. 11.

† The species is an individual of a higher rank (higher power). *Link*, l. c., p. 11.

‡ Cf. the Author's work on *Verjüngung* (1849), note to p. 344.

in the successive generations to which it belongs. This succession may be similar or dissimilar, simple or complicated by divisions, continuous or graduated by cyclical changes. It is by this that the phenomena of fissiparous and alternate generation may be explained. It is only by a consideration of these relations that the nature of the individual itself, as a subordinate sphere of the species' development, can be rightly comprehended, and that the single individuals in their worth and importance, in their relations to each other and to the whole realized cycle of the species, can be understood.

Preliminary remarks on Vegetable Individuality: different views in regard to it.

We must determine what constitutes the vegetable individual, before we can investigate its relations to the whole cycle of generation of the species. But it is this determination itself which presents so many difficulties; and these difficulties become the greater, the further we push our investigations. Individuality in plants seems as obscure and ambiguous, as in animals (at least in their higher orders,) it appears clear and simple; so that, as Steinheil remarks, it escapes us just when we are upon the point of seizing it;* and investigators might even conclude that we can realize no other individuality than that which is manifested in the totality of the species. The first obstacle to our comprehending the vegetable individual as a single sphere of conformation, as a morphological whole, is the disconnected and separate character which obtains in the most heterogeneous modifications of vegetable organisms. For no where in the vegetable kingdom do we perceive that indissoluble connection, and those pervading reciprocal functions, which in the animal kingdom we are accustomed to associate with the idea of an individual organism. Nevertheless, by starting from a comparison with animals we get an apposite point of departure for a comprehension of the plant's individuality. Among the higher animals, the individual appears as a member of a race produced by sexual generation; and this very test may be applied to plants, except in the very lowest forms, to which sexual generation does not apply at all, or not positively. Without at present discussing the question whether the vegetable individual thus conceived is truly analogous to the animal individual, we may here state, that this conception carried out to its consequences, involves the assumption that all the plant-stocks produced, not by sexual generation, but by any mode of vegetable division, are not individuals, but only parts of the primary individual to which they owe their origin; as Gallesio has

* "Dans chacun de ces organes nous nous croyons au premier aspect sur le point de saisir l'individualité normale, et partout elle nous échappe." *Steinheil: De l'individualité végétale* (1836), p. 9.

in fact contended.* Botanists have often asserted that it is the individual† alone, which is reproduced by slips (branches, buds, tubercles etc.), and their opinion coincides with this view. Still, how are we to distinguish plant-stocks of such an origin, from those derived from seeds? The former take root, ramify, blossom, ripen their fruit and seeds, just as the latter do, so that in a physiological sense they are complete individuals.‡ For example, let us cast a glance at the weeping-willow (*Salix Babylonica*). It is well known that this tree, which was originally brought from the banks of the Euphrates, is always propagated by slips; for with us it never bears seeds—not because our climate is unfavorable, but because in our gardens there is no fructifying male tree.§ According to Loudon (*Arboret. Brit.*), the weeping-willow was sent to England in 1730, by a French merchant named Vernon. It was planted in Twickenham Park, whence it spread rapidly over England and the continent. The tree, from which the first slips that were brought to Europe were taken, was most probably a cultivated one itself, raised from a slip. However this may be, could the descent of all our weeping-willows be traced, it would undoubtedly lead us back to a willow, a female willow, grown in its native country from a seed. And so, on this account, we are to regard all the beautiful weeping-willows of our gardens and our cemeteries—and surely they are perfect trees—not as individual stocks, but as the *disjecta membra* of a primary trunk, now hidden in mythical darkness! In other cases this pri-

* *Gallesio: Teoria della riproduzione Vegetale* (1816), a work, which I am sorry to say I have not been able to consult myself. *Huxley* (upon Animal Individuality, in the Ann. and Mag. of Nat. Hist., June 1852), holding corresponding views, regards all the animals which spring from an egg by non-sexual increase, as *one* individual, or, as he expresses it, as a representative of the individual by successive coëxisting separable forms;—regards as such, for example, the sum total of all the *Aphides*, produced in successive generations, by non-sexual increase, from the first "nurse" which sprung from the egg. If we assume with *Bonnet* that one nurse encloses one hundred young Aphides in the tenth generation (and according to *Kyber* they often reach even a higher number) the series would amount to much more than a billion (1,010,101,010,101,010,101). Those who regard sexual reproduction as the criterion of individuality must admit this as a perfectly legitimate consequence of their view.

† "Gemmæ individuum continuant cum semina speciem propagent." Link: *Elem. phil. Botan.*, ed. II, v. i, p. 332. "Continuant," in antithesis to "propagent," cannot be mistaken. Again Endlicher und Unger: *Grundzüge der Bot.*, p. 85, say, "In these cases (i. e. when the buds drop off) the bud-formation is a true propagation, by which the individual is multiplied; though we must distinguish this mode of propagation from that of generation, by which the species is reproduced." Here the meaning is obvious, though the expression is perfectly paradoxical; for how can we imagine that the individuals are multiplied without the species being reproduced? I have elsewhere attempted to show what is here meant, by representing non-sexual propagation as a propagation *subordinate* to the cycle of sexual reproduction (cf. *Verjüngung*, pp. 26, 27).

‡ In many cases the experienced gardener can distinguish them, but certainly not in all; in some the difference is very remarkable: e.g. in *Araucariæ* raised from branches.

§ This has the advantage of avoiding the disagreeable seed-down. For the same reason, it is said, in China they cultivate the male tree only.

mary trunk is known with perfect certainty. It can be proved by history that many hybrids and varieties have been produced in one single exemplar; though they now ornament our gardens far and wide, having increased by means of slips, as they do not bear seeds. This was the case of the famous *Cytisus Adami*, which sprung, shortly before the year 1825, from the mingling of *C. purpureus* and *C Laburnum*. The single parent-stock, preserved in the garden of the celebrated Adam in Paris, has long since disappeared; but its scions and scions-scions, have grown up into fine trees in half the gardens of Europe.* In the view just stated, they all form but one individual! To support such a view, its partisans adduce the fact of certain individual particularities being preserved (in diœcious plants especially the gender), when propagated by slips. In general this is true, and for practical gardening, e. g. for the cultivation of the finer kinds of fruit, of the greatest importance; but exceptions are not rare; among which the well known re-division of *Cytisus Adami* into its two primary stocks is one of the most striking and remarkable. In our gardens the rule is that from slips the weeping-willow produces female trees; still some exceptions may be noted here. Napoleon's grave in St. Helena is shaded by a weeping-willow, which has become the subject of scientific discussions. It was supposed to belong to a species (*Salix Napoleonis*) indigenous to that Island; but Loudon's exhaustive researches show that it is descended from our weeping-willows, one of which was carried from England to St. Helena in 1810. Branches of this *Salix Napoleonis* were brought back to England, and to the astonishment of botanists they bore *male* flowers. Since up to that time no male weeping-willows had been seen in England, a change of gender must have been produced through vegetative increase. A similar case has also occurred in Germany. In the Grand-ducal Gardens at Schwetzingen there is a weeping-willow which, although a descendant from the common parent tree of all European weeping-willows, has changed its gender to such a degree that we not only find on it the most heterogeneous stages of transition from female flowers to male ones, but on many branches purely male catkins are produced.† Besides these cases, a curled variety of weeping-willow *Salix crispa* or *S. annularis* of the gardens, is known; which, as it is a mere garden plant, has probably been produced by slip-propagation. If it be true that we sometimes obtain varieties with hanging branches from several kinds of trees by grafting the slips inverted, we should have one of the most remarka-

* Cf. *Verjüngung*, pp. 337 and xi. In another place I shall communicate the history of this hybrid, which has since been investigated.

† This tree was first observed by *C. Schimper* in 1827. Some remarks upon it may be found in *Spenner's Flora Friburgensis*, vol. iii, p. 1061.

ble examples of the production of a singular peculiarity by non-sexual increase. But even if such exceptions did not exist, and if in every case a series of peculiarities which are extinguished in seminal propagation were continued by grafting, yet we cannot perceive how we can seriously refuse an individual existence to such stocks as these, produced, it is true, by non-sexual propagation, but still completely separated externally, developing in different places and under the most dissimilar relations, and exhibiting subordinate differences indefinitely, though with certain similar characteristics. But if we were to make any concessions on this point we should be carried irresistibly on to others.

Most of the modes of non-sexual propagation thus far considered agree in this particular; that some *shoot* of the plant, whether it be undeveloped (eye, bud), or developed (branch, sucker, layer, &c.), is separated from the parent-stock by natural development itself, or by artificial means. As the nature of the separable part is not changed by the separation, it is no great step to attribute individuality to the shoot, (or as it is commonly called, the bud,) even when it is not separated from the stock. Each single plant-stock could then be no longer regarded as an individual in the usual meaning of the term, but as an united family of individual shoots;—a view which seems to be of high antiquity; as passages are found in Aristotle* and Hippocrates†, which are interpreted in this sense. In later times, this view has been more or less, advocated, especially by De la Hire,‡ Linnæus, Darwin§, Batsch, Goethe, Röper, Schleiden‖ and others.

But, even in this narrower view of vegetable individuality, the same difficulty meets us; for the shoot itself is divisible, and new stocks may be produced by its parts: i. e. by the members of the

* Cf. *Wimmer: Phytologiæ Aristotelicæ Fragmenta*, §§ 23–28, 66 et 113. I cannot discover that explicit acknowledgment of the individuality of shoots or buds, which is said by Schultz (*Anaphytose*, p. 24) to be found in Aristotle, either in Schultz's quotations, or even in Wimmer's complete collection of the passages in Aristotle referring to plants. It is true that Aristotle repeatedly speaks of the divisibility of plants; says that separated parts of plants may continue to exist; that on this account many trees may spring from a single source; that many plants are propagated by slips (ἀπὸ σπαραγαδάτων ἀποφυτευομένων), and by lateral bud-formation (τῷ παραβλαστάνειν) e.g. the bulbous plants; but he does not state his opinion of the parts which develop after such a separation, and explains the phenomena in general, by saying that the vegetable soul of plants (θρεπτικὴ ψυχὴ) is simple in actuality, (ἐντελεχεί) though multiple in capacity (δυνάμει).

† According to *Moquin-Tandon: Teratologie*, p. 5.

‡ *Hist. de l'Acad. Roy. des Sciences*, 1708, p. 233. De la Hire regards all the branches as new plants proceeding from hidden ovules. Myriads of these ovules, he thinks, exist between the bark and the wood; more or less of them come to maturity, according to circumstances.

§ *Darwin: Phytologia* (1800), p. 1. "If a bud be torn from the branch of a tree, or cut out and planted in the earth . . . ; or if it be inserted into the bark of another tree, it will grow and become a plant in every respect like its parent. This evinces, that every bud of a tree is an individual vegetable being, and the tree therefore is a family or swarm of individual plants . . . ."

‖ I shall consider the views of these authors more at large in the next section.

stem and its leaf or leaf-whorl.* Besides, the several members of the shoot are not contemporaneous creations, but, developing successively out of and over each other, they constitute a successive generation, composed of divisions each of which repeats essentially the same form, each of which may be compared to the embryonic plant originally developed in the seed, and consisting of its stemlet with one or two leaves (cotyledons). Thus the shoot itself came to be regarded as a *succession of individual vegetable members*, built up one above the other, like the stories of a house. The earliest traces of this view may be found in *Darwin's Phytologia*;† it was developed at a later period in various ways and with various modifications: e. g. by Agardh‡, Engelmann,§ Steinheil‖ and Gaudichaud¶—the last of whom calls the member of the shoot elevated to the rank of an individual vegetable being, "the phyton," and ascribes to it not only a stem and leaves, but even a root, by which he imagines it is connected with the preceding phytons, as the first phyton (the embryonic plant) is connected with the ground. Steenstrup** and Forbes†† employ a similar view for their comparison of alternate generation in plants with that in the lower animals.

But this restriction of vegetable individuality could not stop here; for even the members of the shoot, the "phyta" or "stories," are themselves too complex organisms not to present subordinate divisions, which, like the whole member possess a certain independence, and under certain circumstances may even give birth to new stocks. Although botanists have attempted to view the petiole as the lower part of the leaf,‡‡ or, vice versa, the leaf as the upper part of the petiole,§§ (so as not to be compelled to divide the phytons of the structure themselves into rel-

* I adduce this point in connection with the history of the views held by botanists in regard to vegetable individuality, in the terms in which it has been usually expressed; further on I shall show that this view needs qualification. The individual members of the stem cannot expand into a new stock by direct development, like the separated shoot; they have this property only by being connected with a lateral sprout, by means of the eye which they bear, or have the power of producing. This view naturally brings us back to the shoot as the individual.

† P. 9; where even the single well-defined stem-members of different herbaceous plants are described as so many buds, and hence as so many individuals.

‡ *Agardh: Essai de réduire la Physiologie végétale à des principes fondamentaux*, 1829, (Ann. des Sci. Nat., tom. xvii, p. 86).

§ *Engelmann: de Antholysi*, (1832) p. 12.

‖ *Steinheil: l'Individualité dans le regne végétale.* 1836.

¶ *Gaudichaud: Recherches sur l'Organographie, la Physiologie et l'Organogénie des Végétaux.* 1841.

** *Steenstrup: On alternate Generation* (1842), p. 128. As this important little work may be supposed to be in every one's hands, I refrain from quoting this interesting passage.

†† *Forbes: On the Morphology of the reproductive system of Sertularian Zoophytes, &c.*, Ann. and Mag. of Nat. Hist., v. xiv, (1844), p. 385.

‡‡ *Ernst Mayer: die Metamorphose der Pflanze und ihre Widersacher.* Linnæa, 1832, p. 401.

§§ *Hochstetter: Aufbau der Graspflanze.* (Würtemberger Jahreshefte, 1847 and 1848).

atively independent members) this much at least is certain (and it is the important point here), that each of these two parts is capable of producing new growths by itself, yes, this capacity is enjoyed even by different determinate or casual parts of either member. It is well known that the leaf of *Bryophyllum* produces sprouts in every notch on its edges, while on the other hand, caducous leaves of many bulbous plants (e. g. *Eucomis regia*, according to Hedwig, *Ornithogalum thyrsoides* according to Turpin)* produce new plants in the form of bulblets on any portion of the whole of the upper surface. The petiole itself under certain circumstances, has the power of producing the so-called adventitious buds, not only on the portions determined by the position of the leaf (leaf-axil), but sometimes on any other portions; a power enjoyed by the root in many cases. Hence parts of plants, otherwise most dissimilar, when they contain cambium, may have the power of reproducing the plant.† This is the foundation of the *Schultz-Schultzenstein-ian* doctrine of *anaphytons;* viz., those vegetable members "which, even when separated from the plant, continue to live, bud, and develop,"‡ and which are hence regarded as the individuals proper, as the true elementary forms or morphological elements; and it is by various combinations of these that the organs (commonly so-called), root, stalk and leaf, are formed, by the repetition of which the whole plant is built up and indefinitely renewed.

But where are the limits of the anaphytons? How shall lines be drawn to include all the buds of the root, stalk and leaf, from which new formations may spring? Aub. du Petit Thouars§ who had already developed doctrines similar to those of the anaphyton-theory, attempts to draw the line between individuals by means of the cellular tissue, regarding every vascular bundle as an individual, since it has in itself, and independently of all others, the means of its growth, its preservation, and the reproduction of new bundles. But it is difficult to perceive how, in such a view, the labyrinth of anastomosing bundles, (not less complicated in the majority of petioles, than in most reticulated leaves,)

* Cf. *Treviranus: Pflanzenphysiologie*, where several examples are adduced.

† Aristotle himself says that plants possess the power of reproducing "stalk and root" in every one of their parts. (πανταχῆ γὰρ ἔχει και ρίζαν καὶ καῦλονὶ δυνάμε. Vit. long. et brev. c. 6, p. 467).

‡ *Schultz: die Anaphytose* (1848) and, *System der Morphologie* (1847). The passage quoted is taken from his later work, Verjüngung im Pflanzenreich (1851). The remark made above, when treating of the members of the petiole, holds good here. The so-called Anaphyta can by no means grow into new plants themselves; on the contrary, the new plant is produced as a germ, which is not identical with the anaphytons.

§ *Essais sur la végétation considérée dans le dévéloppement des bourgeons* (1809) cf. e. g., p. 174. "C'est donc le bourgeon en qui réside toute l'énergie végétale; aussi le regarde-t-on depuis longtemps comme un individu ..... D'après les principes que j'ai développés dans mes précédens mémoires, il faut aller plus loin, car je crois que chaque fibre végétale est un *Individu*, puisqu'elle a en soi, indépendamment des autres, les moyens d'accroissement, de conservation et de réproduction."

can be disentangled and resolved into separate individuals and why the same independence and the same rank should not be allowed to the parts of the vascular bundles. And how shall we regard the lower plants, which have no fibres at all? If our conclusions are to be anything more than mere arbitrary assumptions, we must go still farther; and we shall find no halting-place till we reach *the cell*, the true seat of every renovation in the plant, the starting-point of all non-sexual increase,* as it is of sexual propagation.† The cell has a better right to be considered as the vegetable individual than any other subordinate member of the plant; when connected with other cells it still continues to be an independent sphere of formation, sharply defined and, in youth at least, completely isolated.‡ Before the universal law of cell-formation was known, and before botanists had succeeded in reducing all the elementary organs of plants to cells, Turpin hit upon the idea of seeking the vegetable individual in the cell; though his views did not rest on as solid a foundation as Schleiden's assertion that: "in a scientific point of view, the cell is the vegetable individual."§

The most reliable authorities have agreed that new cells can never be formed externally to, but only within, other cells already formed,¶ so that cell-multiplication must be regarded as a propagation, while all the cells of the mature plant must be regarded as the progeny of the first embryonic cell. Besides, each and every plant is at first a cell; and there are single-celled plants in the strictest sense of the term, in which the first formation of new cells is that destined to reproduction; i. e.: the germinating cells or spores.** Again, there are other plants in which the cell-generations contained between the first generation (which

* Earlier investigations into the origin of adventitious buds had made it probable that, in its formation, each new shoot arises from a single cell. The first convincing proof of this fact, was given by *Hofmeister* (Vergleichende Untersuchung u. s. w. der Coniferen, p. 94), in *Equisetum*. The propagating cells on the foliage and edges of the leaves of liverwort, which develop into new plants, have long been known. The spores of the Cryptogamiæ belong here, as they are cells originating and developing non-sexually.

† Pollen-cells, and the embryonic utricle and germinating cells,—as well as those of the archegonium of the higher Cryptogamiæ.

‡ Malpighi himself (Anatom. Plant., 1675), calls cells utriculi, or sacculi, though he distinguishes the wood and bast-cells as "*fibræ*," the vascular cells as "*fistulæ*" and the cells containing milky sap as "*vasa specialia*." As early as 1805, Link (Römer's Archiv., iii, p. 439), had expressed himself very explicitly in regard to the isolated position and the independence of cells: "Quaevis cellula sistit organon peculiare, nullo hiatu nec poris conspicuis præditum in vicina organa transeuntibus. Conspicies non raro cellulam rubro colore tinctam inter reliquas virides."

§ *Schleiden: Grundzüge*, 1te Aufl., 1842, vol. ii, p. 4, [Eng. trans. (1849), p. 127 T.]

¶ Cf. *Schleiden: Grundzüge*, i, p. 267 [Eng. trans. p. 103 T]. "The process of the propagation of cells, by the formation of new cells in their interior is an universal law in the vegetable kingdom." *Mohl: Anat. und Phys. d. veg. Zelle*, 1851, p. 53. "Cell-formation in plants takes place only in the cavities of older cells, not between or upon them." *Schacht: die Pflanzenzelle* (1852), p. 47. "The formation of new vegetable cells always takes place in the interior of cells already formed."

** E. g.: *Ascidium, Chytridium, Codiolium* (a genus lately discovered in Heligoland) *Sciadium, Hydrodictyon* (the last two with "colonial formation").

sprung from spores) and the last (itself returning into spores) separate from each other, so that all the cells belonging to one cycle of vegetable development are segregated, and live completely independent of each other.* The importance of the cell as an individual seems to be decided by these facts; that of the entire plant, as a superior whole composed of individual cells, seems to be settled, and a firm foundation for the doctrine of vegetable individuality to be gained. But let us try to obtain a clearer view of some of the most important of these facts. The view which regards all cell-formation as a process of reproduction rests upon observations of the formation of free daughter-cells (blastidia) in the contents of the mother-cells (matrices),—the so-called *free*, or *endogenous*, cell-formation. Schleiden, who discovered this process, and Karsten† the most decided and original of his followers, regarded endogenous formation as the universal law of cell-formation. By this view the whole doctrine was turned in a wrong course, from which it could only be gradually recovered by the discovery, or rather the farther investigation, of another mode of cell-formation, which Nägeli designated as "wandständige," Unger as "merismatic," and Mohl as "cell-formation by division of the primordial utricle." But even at this day the misconception caused by generalizing the view that new cells are formed *within* old ones, has not been entirely removed. I have already‡ called attention to the fact that cells are divided which have no cell-wall, which is often the case among the Algæ.§ In several genera in which numerous spores are formed in one mother-cell, its entire contents first divide into two parts (the so-called daughter-cells) which, without first secreting a cell-wall, immediately divide again into two; and this process may be repeated over and over,‖ according to the number of spores which are to be formed (8, 16, 32, &c). In the second and subsequent divisions there is no formation of new cells *in* old ones, of daughter-cells *in* mother-cells, and hence no reproduction, in the sense of one or more individuals being produced *in* an old one. The *entire* mother-cell is converted into two filial cells; the filial cells are nothing but the mother-cell divided. And this is essentially the case in every cell-formation by division: for the wall of the mother-cell (within which the division gener-

* Many Palmellaceæ, Desmidiaceæ, and Diatomeæ. Cf. *Braun: Verjüngung*, p. 132, et seqq.

† H. Karsten, (*De Cella Vitali*, 1843,) emphatically rejects every mode of cell-formation by division and by sprouting, and asserts that every cell originates at its first appearance as a dot-like utriculus; regarding all formations found in the contents of the cell as cell-brood.

‡ Cf. *Verjüngung*, p. 245.

§ E. g.: Protococcus (viridis), Characium, Pediastrum, Ulothrix, Enteromorpha, Ulva, etc. during the process of spore-formation.

‖ Nägeli (*Monocellular Algæ*, p. 28) calls such cell-generations "transitory generations."

ally takes place) certainly is not the living mother-cell, but merely its cast-off garment, its perishing shell. Cell-formation by division (called the "merismatic" or "wandständige") is that which obtains through the whole realm of vegetative development; while free cell-formation occurs only in fructification. Thus, the same phenomenon, which, regarded as endogenous cell-formation, seemed so favorable to the importance of the cell as the vegetable individual, when more justly comprehended only brings us back to the divisibility of the vegetable organism, repeated in the most heterogeneous spheres. But still more: even the cell whose contents are not converted by division into new cells, but remain simple, presents phenomena which can hardly be reconciled with their view by those who regard such a cell as an individual, isolated in space and independent in time. In the genera *Vaucheria*, *Bryopsis*, *Caulerpa*, and other related Algæ in the family of *Siphoniæ*, we find such cases, examples of the most extraordinary kind of cell-formation. The single cell, which forms the vegetable organism of these plants, has in fact a development which may continue indefinitely. Certain parts of the elongated stem-like cell shoot forth into branches which lengthen by an independent terminal growth, without separating from the cavity of the maternal trunk by any partition. The principal trunk of the cell is either creeping, with an indefinite terminal growth though dying off from behind (*Caulerpa prolifera*),* or it is upright and deciduous, while the sucker-like branches, club-shaped at the ends, and filled with a denser contents, are perennial (*Vaucheria tuberosa*).† In both cases the branches separate from the dying trunk, closing up at the bottom; and thousands of new trunks may thus be produced without any proper cell-formation. Thus the cell leads us back to the point from which we started at the tree; and, as we could not refuse individuality to the ramifications of the tree, neither can we refuse it to the ramifications of the cell. Hence we cannot regard the cell as an absolutely single being, completely isolated and indivisible. Shall we penetrate still further into the anatomy of the cell itself, in the hope of possibly finding a valid vegetable individual? All that we discover here is, first, the vesicles, spherules and granules in the contents of the cell (amylum, chlorophyll and other pigment-vesicles, spherules of fat and, finally, the granules of the viscous cell-contents, whose chemical nature it is difficult to determine); and secondly, the fibres, which compose the cell-membrane according to the old view advanced by Grew and lately revived by Meyen‡

* Cf. Nägeli's important paper on this plant (Zeitschrift für wissen. Bot., i, p. 134), especially the exposition of the above-mentioned relations beginning p. 158.

† A new species from the vicinity of Lake Neuenberg in Switzerland, remarkable for its purely furcated ramifications, with constrictions at the bottom of the branches, as well as for the club-shaped suckers at the ends.

‡ *Meyen: Pflanzenphysiol.*, i, p. 45; answered by Mohl, in his *Vermischte Schriften*, p. 314.

and J. Agardh.* These parts, it is true, have often been regarded as the elementary forms† of plants, or their primary "individualized" bodies;‡ the attempts, however, to represent them as the true and real vegetable individuals are not numerous; and they astonish us by their daring rather than entice to imitation. Turpin, who commenced by considering plants to be composed of different kinds of individual cells, which he compared with various lower plants (especially the Algæ-genera *Protococcus* and *Conferva*), afterwards expanded his views, so as to regard the cells themselves as individuals of a second rank; while he considered the true primary individuals to be the granules of the cell-contents, from which, in his opinion, the cell (cell-wall) is formed by agglomeration.§ Mayer of Bonn, basing his theory upon molecular motions, considers the smallest granules of the cell-contents as individuals possessing animal life (biospheres) which build up plants for their dwellings. "Like hamadryads these sensitive monads inhabit the secret halls of the bark-palaces we call plants, and here silently hold their dances and celebrate their orgies."‖

Farther than this we cannot go: if we did we should have to leave *specific* vegetable life, and, instead of investigating its most minute spheres of formation, the visible cells, vesicles, granules or monads, turn to the invisible *individua*¶ of brute matter, so as to consider plants as phenomena of appellant and repellant, coherent and incoherent atoms. If we must understand by an in-

* *J. Agard: de Cell. Veg. fibrillis tenuissimis contexta* (1852). Notwithstanding the importance of the author's new investigations, they still need a more searching examination, as some points directly contradict well-ascertained facts, e. g.: the direct transition of the fibres from the outer to the inner layers of the cell-wall. The whole theory of the formation of cells by the uninterrupted growth of fibres cannot be admitted in view of the undoubted independence of the formation of the cell-wall from the contents. Mohl is certainly right in regarding the fibrous division and divisibility of many cellular tissues as a mere structural relation of the membrane (which in other parts is continuous); and he thinks it depends upon the peculiar mode of agglomeration of the molecules. As such molecules of the cell-wall are invisible, I think it preferable to regard it as dependent upon a regular change of the relations of density.

† *Kützing: Phil. Bot.*, i, p. 125, 129, does not regard the cell as the elementary form of plants, but as a complicated structure itself, and preceded by many other more simple forms, which he comprehends under the name of "molecular tissue," and which, he says, present in themselves many lower vegetable forms. Plants which are not even cells!

‡ *Unger: Grundz. d. Anat. u. Phys. der Pflanzen*, p. 4. The cell is represented as the "elementary vegetable organ;" but the vesicles, fibres and granules within it are further distinguished as very minute, "individualized" bodies.

§ *Turpin: "Sur le nombre deux,"* (Mém. du Musée, xvi, 1827, p. 305): "Ainsi des individus globuleux, rapprochés simplement contigus, forment la membrane de la vésicule Individu du tissu cellulaire, le filament Individu du tissu tigellulaire, et la membrane cuticulaire Individu. Des agglomérations de ces derniers constituent les Individualités, provénantes des bourgeons développés, et enfin, celles-ci achèvent l'*Individualité composée* d'un arbre."

‖ *Mayer: Supplemente zum Lehre vom Kreislauf* (1837), p. 49. I am acquainted with Mayer's views through Meyen's Pflanzenphys., ii, p. 256.

¶ Cicero calls the atoms "Individua."

dividual, a being perfectly simple and indivisible, this is our last refuge, in which we may indeed reach an individual, but not a *vegetable* individual; for this would then be identical with the material individual common to all corporeal existence. But, even if we could give up all hopes of a specific vegetable individual, doubt would still linger round these physical individuals; for even the existence of the universal primary particles of bodies,—the material individuals, the atoms,—is not conclusively established. No eye has seen them; we do not even think of considering them as objects of direct perception; we only accept them as an hypothesis, to eke out our theories of motion and of chemical affinity, and to enable us to compute their relations. The question might easily be asked, whether the same phenomena may not be as well explained by assuming the continuity, expansibility and penetrability of matter. However this may be, the question concerning the existence of atoms certainly lies beyond the limits of botanical investigation; and if the existence of vegetable individuals depends on this question, the botanist must despair of proving it. Thus the question at which we have now arrived is this: can we speak of individuals in botany? and this is identical with another: are plants mere products of the operations of matter (i. e., of a substance self-moving, uniting and separating by an innate force), and hence non-entities, or mere phenomena resulting from, or produced by, the blind forces of nature; or may we ascribe to plants an independent existence in nature, notwithstanding their connection with the external world?

If what we call plants are nothing but complex chemical and physical *processes*, then we can no longer speak of their individuals and species in the sense the words usually bear; for the mere phenomena of the operations of the primary substance, which have no other efficient principle than the forces of this substance, cannot be regarded as self-existent beings, or as peculiar (specific) kinds of these beings, or as single (individual) modifications of them. This is, in fact, the result towards which the later physiological investigations are hastening, grounded on the positive results of investigations in the physical sciences. Even vegetable physiology cannot resist this tendency of science, although it struggles more or less against these conclusions.* The operations by which plants, and all organic beings, form and preserve their organisms, were formerly ascribed to peculiar vital forces; but the physiology of our day would recognize in the vital functions of the organism the same forces by which the processes of inorganic nature are perfomed. Thus physiology becomes

* Even Schleiden, the most prominent and most decided of the representatives of this tendency, seeks to counterbalance the deadening effects of the purely materialistic view by an æsthetic one (Die Pflanze und ihr Leben; last lecture: d. Æsthetik der Pflanzenwelt).

physics and chemistry, or, according to the usual conception of the physical and chemical processes themselves, the "mechanics" of organic nature in the most comprehensive meaning of the term mechanics. And thus the life of the enchanter is unveiled, who had seemed to be the immediate cause of his own works; the lofty partition-wall between organic and inorganic nature falls, and one common foundation is laid for investigating all material processes in every realm of nature. This important result is reached: the existence of the higher orders of natural phenomena, which had been regarded as the peculiar realm of Life, is referred to the same natural causes (the same material substance and the same kind of forces) by which the lower orders, those of "inanimate" nature, have their being and perform their functions. Still further conclusions may be attempted, and it is in the nature of scientific progress that these attempts should be made. As physical forces seem to be everywhere indissolubly connected with matter, and as a fixed regularity displays itself in their operations, men were found bold enough to consider the totality of natural phenomena as the result of original primary substances, coöperating with determinate forces, according to the laws of a blind necessity;—a natural mechanism revolving in its endless orbit.*

Though this view seems to explain all the phenomena of nature from one principle, in fact it precludes any real explanation of them, that is when exlusively applied to their solution. That which is eternally necessary can only be conceived as eternally carried out; and thus any real event becomes an absurdity. If the "mechanical" (physical and chemical) forces of nature are necessarily active, then if any motion is to take place, the first impulse, the proximate cause, cannot be explained by the nature of the motion; it must be another principle above necessity; and this is true not only of nature as a whole, but also of every particular motion in nature as well. Thus not only the first impulse, but the universally apparent final cause, remains an inexplicable riddle in the doctrine of blind necessity. Hence the insufficiency of the "physical" theory, compared with the "teleological"† is peculiarly obvious in the realms of organic nature, where the

* As far as concerns Natural History these views are developed, e. g.: in both of Mohlschott's works: d. Physiol. des Stoffwechsels in Pflanzen u. Thieren, (1851), and d. Kreislauf des Lebens (1852); in the last mentioned work we find such sentences as these: "The miracle of nature is the interchange of matter, the first-cause of physical life," p. 83. "Creative omnipotence means the relations of matter," (p. 258). "The hinge round which the wisdom of the present day is turning is the doctrine of the interchanges of matter," (p. 363).—The doctrine, that the universe is the play of attrahent and repellant atoms, belongs, after all, to the "wisdom" of the past, professed by *Democritus* and *Epicurus.*

† Cf. *Schwann: Microscopische Untersuchungen* über die Uebereinstimmung in der Structur u. d. Wachsthum d. Thiere u. Pflanzen, (1839), especially p. 221–225; on the other side, *Eschricht d. Physische Leben*, (1852), in sections ii and iii.

final cause of each particular life appears so distinctly. The advocates of the physical view perceive this; but they explain the fitness of means to ends in nature as a whole, and in its individual parts, by supposing matter, with its blind forces, to have been created by an intelligent being.* But we can regard this as a germ of an explanation only in proportion as it is also granted, that the intellect of the Creator lies not only behind and without nature and her processes of development, but that, as if incorporated in nature, it is taken into the destiny of each created being, in proportion to its individuality. But this, again presupposes the admission of a substantiality of nature fit for such an hypothesis;—a substantiality not grounded on mere matter, like a blind force; but which, on the contrary, must comprehend matter as subordinate to itself, and must realize itself through matter:—an assumption which modifies the physical view essentially, and would seem to be a modification of some ideal, or teleological theory.

Without underrating the great importance, which the physical view possesses for vegetable physiology, still we must confess that we cannot find in it the key to a conception of vegetable individuality: for, after all, this must be sought for, not in the external conformation, but in the essence of the plant, determined from within. This leads us from the last negative results to an historical view of the attempts at a positive explanation.

It is evident from the foregoing review that, if we would not give up all hope of conceiving plants as *beings, realized in individual conformations*, we must not allow so great and decisive an importance to the external divisibility of their organism as has been usually done. We must seek a decision in the essential concatenation of all the steps in the plant's development forming one whole, according to one idea. This is the tendency of the concluding remark of Nägeli, to which he is lead by the relations of growth and propagation in *Caulerpa*; when he says that indivisibility of form is not an element essential to individuality,—which, indeed must be constructed upon a new, and somewhat less material a basis. Link calls attention to this same unity, which is expressed in the whole development of the plant, and which forms the essence of its individuality, in the following true words: "We cannot recognize an individual unless we are convinced that it remains the same in different periods of its existence."† Now the question is just this: how can we perceive

* "The fitness of means to ends, in every organism, even a superior degree of this individual fitness, cannot be denied; but in this (the physical) view, the cause of the fitness does not consist in the fact that every organism is produced by an individual force tending towards a certain end, but, like the cause of the fitness of means to ends in the inorganic world, that matter is the creation of an intelligent being." Schwann, l. c., p. 221, and, in almost the same words, p. 224.

† *Link: Elem. Phil. Bot.*, Ed. ii, p. 11.

such a oneness of essence amid these changes of form and material? How do we perceive that, with all its divisibility, the plant remains after all really one and the same individual?

Every development presents a succession of phenomena, which, while they present themselves in a regular order, also show unmistakably a point of departure, an end, and a course between the two advancing after a fixed plan, and which indicate a common internal principle.* They point to an internal vital principle,† common to the whole succession;—to a principle which must be conceived of, not only as an idea which guides the whole process, or as a force determining the specific type of this plastic succession, but also as a living essence, comprehending the idea as its internal determination, and the force as the means of its realization;—an essence which precedes and shapes the external existence; as intentions precede and determine acts.‡ If, in ac-

* *Du Petit-Thouars*, l. c., p. 284: "L'individu est un être dont toutes les parties sont subordonnées à un principe unique d'existence." *Link, Elim. Phil. Bot.*, ed. ii, p. 3. "Nos individuum vocamus, quod ab uno eodemque principio interno determinatum est, ad idealem potius quam ad realem respicientes divisionem."

† *Spring: Ueber d. Begriffe v. Gattung, Art u. Abart*, (1838), p. 55. "It is this indwelling principle which makes the individual; and in natural history, every body is an individual in as far as it really exists as a single being, whose existence is determined by a peculiar indwelling vital principle." Spring afterwards distinguishes the *systematical* and the *physiological* individual: in the former one moment of the development is comprehended, in the latter the whole metamorphosis. The physiological individual comprehends an assemblage of forms, which might be regarded by a casual observer as so many systematical individuals.—Still, a true systematick must protest against such a purely subjective distinction of systematical and physiological individuals. However much the embryos of mosses resemble Confervæ, or the larva of an insect resembles a worm, a true systematick will not separate the young individual from the developed one; and genera which are founded upon our ignorance of their successive development, as *Protonema, Lepra, Sclerotium*, etc., must be given up by the systematist himself. True, we shall be called upon at a later point in this inquiry to decide, whether a sphere of development which really belongs to the individual can present itself to us so divided that the divisions themselves attain to the importance of subordinate individuals.

‡ Aristotle describes the internal essence of plants as a "plastic soul," (θρεπτικὴ ψυχή, τοῦ ζῶντος σώματος αιτία καὶ ἀρχή). Cf. *Wimmer: Phytol. Arist. frag.*, c. iii, de pl. vita atque anima. The charge of anthropomorphism has been made against such a view, which attempts to conceive of nature as a chain of essences, both in the reciprocal relations of her forces, and in her internal developments; but, if man himself is a member of nature, if he is the highest member in the order of natural beings, that member which presents the most complete unison of all the phases of life in nature,—then all his knowledge of nature must be connected with his knowledge of himself. However meanly we may estimate this knowledge at the present stage of psychological science, still it is sufficient to assure man of his own "ego." And if man is justified in regarding himself as a human being, by analogy he is justified in regarding his relations, the animals, in the same manner, as animal beings; plants as vegetable beings; and every single animal, every single plant, as an individual being (even though included in a higher entity). To attain a unity of idea in Natural History, man must apply this idea farther down in the scale of nature, and must regard minerals, even the elements themselves, as beings of their own kind. But the materialist will reply: individual beings are only the elementary substance: all other beings, so called, are formed by a temporary composition and coöperation of these. But who has seen these elements of chemical combinations, as *elements*, or has proved their existence in any way? But even if they should exist as such, is it not

cordance with this idea, we regard external development as the revelation of the internal essence, which exhibits its purport in the processes it undergoes in connexion with the world without it, and whose realization is thus produced by a determinate sphere of activities, necessary for such a realization, then, *vice versa*, we may infer the essential unity of each particular sphere of development, from the complete unity of the functions relating to this realization. This leads us to the attempts made at a physiological determination of the vegetable individual. The usual definition, and one entirely in accordance with the physiological point of view, is that an individual is a perfect representative of the character of the species, possessing all the functions necessary to the continuance of the species. Now if we would conceive of a physiological individual, in the broadest meaning of the term, we should certainly be compelled to demand that our conception should be such as to exhibit not only single phases, but all the phases of the specific life during its entire develop-

conceivable that a higher being should include the lower beings? We say: hydrogen and oxygen form water; but it would do as well to say, water forms itself out of hydrogen and oxygen. The elements do not form the plant; the plant forms its body out of the elements. We may declare both these views to be hypotheses; but of hypotheses that is preferable which is nearest to man,—I would almost say, most necessary to man's nature, when he proceeds from the data of his own existence. Shall the elements have a stronger claim to be acknowledged as real existences than man himself? Or will any one say that it is a more daring hypothesis to assume that man thinks; that brutes move themselves; that plants themselves produce the determinate form of their organism, than to suppose that elementary substances in their connexions and coöperations produce the phenomena of thought, voluntary motion and typical conformation? But after all, is it not true that the elementary substance is everywhere present? that without it none of the phenomena just mentioned can occur? Certainly, this is so; the higher stages cannot be realized without the lower, which enable them to exist; but these higher stages can never be explained by, and comprehended in, the lower. No one, as yet, has shown even the shadow of a possibility of explaining, from the things themselves merely, why the elementary particles form a mineral kingdom, a vegetable kingdom, an animal kingdom, and man. And why do they not fulfill their task after an eternal immutable manner, since such a fulfillment is one of their necessary, eternal, and immutable properties? Why have they succeeded in composing man only in the most recent geological epoch? Why have they not from eternity produced in man's brain the theory of their actions, and thus, in accordance wlth their eternity, eternally manifested and glorified themselves? The most industrious investigations into the relations of the physical world promise us a deeper insight into the regular connexions of all the parts of nature; into the cunning mechanism, which carries on and upholds all natural life. Still a key to the interior of this structure, and an admission to the essence of plastic nature in her operations, cannot be found by our investigations if, by presumptuous hypotheses, they debar us from the higher realms of development, especially those of organic nature and of human life. Flesh and blood are hypotheses; but mind is truth, says a well known writer; and Des Cartes could find a proof of his own existence and of that of the world around him in his mind alone. It would be a strange contradiction, if the investigation of the most distant realms into which the human mind can penetrate should rob us of what is nearest and surest, the intellectual *ego* itself, the starting point of all investigations. But he who has not recognized the foundations of the spiritual world in nature itself, must of consequence deny their existence in man, if he would not lose, in an inexplicable dualism, the hope of obtaining coherent views of nature.

ment; that it should realize all the capabilities of the specific being, and thus present to us the whole plan, the whole destiny of the species. If we examine the preceding conclusions from this point of view, it will be evident that single cells cannot be such individuals; for, although the whole construction of the plant and all the functions of its life are carried on by means of the cells, still, viewed as a connected whole, the cells are only single stones, single elements, in the great mechanism of the organism. Any single member of a plant (as the internode and leaf) corresponds no more to such a physiological individual than does the cell; for plants undergo their metamorphoses in their successive members; and the various processes of their preservation, reproduction and propagation are connected with the various steps of these metamorphoses. Nor can it be the shoot; for that usually does not embrace all the steps of the metamorphosis; besides, the functions are variously distributed in the shoot; and in many cases, this takes place for the reciprocal completion of the functions. Besides, whatever is characteristic in ramification and in growth depends upon the combined shoots, and without these it is impossible to conceive of trees, for instance. Then we come back to the whole plant-stock? Nay, farther; we cannot stop at the plant-stock; for the single stocks are far from being perfect representatives of all the phases, and tendencies of the specific life. I would refer to the division according to gender, or the modes of fructification, which is often made in botany; the diœcious and triœcious,* relations, and farther, to the varieties, especially to those which do not possess essential organs and functions, which belong to the species as such; e. g.: those varieties which never bear blossoms (Ball-acacias), or which never produce fruit (congested blossoms), or which never perfect seeds (currant-grape, cultivated bananas and bread-fruit trees). Besides, no stock is exactly similar to another: we ascertain only the limits of the possible relations of the specific form by a comparison of many stocks. As in animal physiology the solution of the problem of the life of many animals depends upon their social relations (societies composed of couples or of flocks, or of self-governing states), so in vegetable physiology it depends upon characteristic physiological traits whether plants live single and dispersed, or in societies. For example, in considering the life of turf-mosses we must determine whether they grow in great sods or in carpets; and of grasses, whether they form meadows; or of trees, forests. Even the relations of geographical distribution, which are discovered by a comparison of all the stocks, depend upon the physio-

* Triœcious plants are exceedingly rare among Phanerogamiæ (Ceratonia, some kinds of Rhus), but are more common among the Cryptogamiæ; perhaps we may add the Floridiæ. In *Polysyphanio violacea* I have found three kinds of stocks mixed, and in the same stage of development in the same place: (upon the same thread in *Chorda Filum*).

logical character of the plants: plants of sensitive and inflexible constitutions are found only within narrow limits; while plants of adaptive and pliant constitutions are more widely distributed, become migratory plants, and by degrees spread over almost all parts of the earth, if their seeds possess the necessary properties. From these considerations, and many others which might be adduced, it is obvious that there are no determinate limits to a purely physiological conception of the vegetable individual; and that we may expand the definition of the individual until it coincides with that of the species itself.

How then can we steer a middle course, between the morphological view, which results in indefinite subdivision, and the physiological, which ends in indefinite expansion? The physiological view has shown that none of the divisions or spheres of formation, which have been regarded as the individual ones, fully realizes the idea of the species; and that each needs the others to render this idea complete. The morphological view has shown, in the same manner, that there are subordinate and comprehensive spheres of development, none of which exhibits complete independence, since all appear in unequal degrees, as more or less perfect members of the entire succession of the specific development. If we would discover the individual under such circumstances, we must not demand of it all that belongs to the species; for this is *completely* represented only in the totality of the individuals, not in any single individual. We must answer this question: Which member of the graduated potential series in the sphere of development subordinate to that of the species deserves *preëminently* the title of individual? And we shall be compelled to reply: That which exhibits the most complete independence and definiteness. Good use has decided in regard to man (and the higher animals), and it justifies itself by the fact, that what is usually termed an individual undoubtedly possesses great organic independence: and this is true both of its subordinate spheres (i. e. the members of the organism, down to the cells) and of those by which the individual is comprehended (family, state, race, etc.). By means of comparison and analogy, the signification of the more doubtful spheres of development among the lower animals and plants may receive some new light from such a view. I propose to attempt this in the second part of this Investigation, but now I will only subjoin a few general remarks.

In the conception of individuality, there are two elements; that of multiplicity, and that of unity. Each development exhibits multiplicity; but this multiplicity is not equally subordinate to the unity in every development. The more complete this subordination, the more perfect is the individuality; for it is only this subordination to the unity which binds up the multiplicity of the conformation into an indivisible organism. The less complete the subordination, the more perfect will be the independence of the parts, and the more indefinite will be the individuality of the whole. If we apply this view to plants, whatever is dubious in our conception of vegetable individuality will be explained. Successive development, we may say, is the peculiar nature of plants, which, beyond the power exhibited in the process of formation and propagation, possess no higher vital power; while in animals the process of the formation of the body appears only as an operation preparatory to its connection with a higher vital activity. For animals, in addition to their powers of external manifestations, have a power of internal vital comprehension, which expresses itself in the life of the soul (by which animals possess an internal centre, from which the organism is governed and regulated). It is the soul alone which connects in indivisible unity, and for reciprocal services the products of the plastic power, and gives to the organism of animals the character of a definite individuality. Among plants the case is different: plants in their operations are active solely in one direction, externally—are split up so to say in the process of external conformation, so that the parts appear less connected, as compared with the plant as a whole more independent, and more divisible among themselves. Thus the vegetable organism is a *dividual*, rather than an individual; a multiplicity* rather than an unity; i. e. a whole whose parts hold the same relation to each other as individuals to each other, but which present spheres as indivisible as the whole itself. This is the doctrine of the *relative*† individuality of plants, which Steinheil has especially noticed. According to this doctrine, different orders of vegetable individuals, as it were different powers of individuality, are distinguished. In the same manner DeCandolle‡ distinguishes the cell-individual (*l'individu cellulaire*, in which he has been preceded by Turpin); the bud-individual (*l'individu bourgeon*, after Darwin); the slip-individual (*l'individu bouture*); the stock-individual, or the vegetable individual (*l'individu végétal* penes quem est jus et norma loquendi); and the embryo-individual (*l'individu embryon*), which, in accordance with the meaning in which Gallesio used the term, comprehends all that proceeds from one germ, even if multiplied by division. Since the

* "Planta est multitudo." *Engelmann: de Antholysi*, p. 12.

† *Steinheil:* l. c., especially p. 4 and p. 17: "Les végétaux ne peuvent arriver à l'individualité absolue; ils se presentent à nous dans un état, qu'on peut désigner par le nom d'individualité relative; ce qui distingue cette partie de la création du règne minéral, où l'individualité est nulle, et du règne animal, ou elle est presque toujours absolue."

‡ *DeCandolle: Physiologie Végét.*, p. 957. The author does not attach much importance to his division, as he says he has assumed it for convenience of expression, and to avoid the usual confusion of language. His son Alphonse DeCandolle considers it quite an arbitrary matter which part of the plant we call the individual: "Les végétaux sont évidemment des êtres composés: mais jusqu' où veut-on les décomposer, pour que les élémens s'appellent des individus? C'est une chose arbitraire, qui dépend de l'idée par laquelle on se laisse dominer" (after Steinheil, p. 6).

slip-individual is essentially the same as the bud-individual (i. e. shoot-individual), we have four degrees of individuality, in which at least one more might have been easily inserted, between the cell and the shoot-individual, i. e.: the member or "story"-individual (Gaudichaud's *phyton*). With this view Schleiden's division is connected: he distinguishes the cell as the plant of the first order; the shoot as that of the second, which he calls the *simple* plant (a term borrowed from C. F. Wolf, who used it in the same sense); the whole stock as that of the third order, which he designates as the *composite* plant By a searching investigation into the shoot, I shall endeavor to decide whether all these relative individuals can be considered *individuals* with the same justice; or whether, after all, one of them does not deserve the title preëminently, corresponding to the animal individual. In either case Gœthe's words may be applied with perfect justice to plants and their individuality:

> Freuet euch des wahren Scheins,
> Euch des ernsten Spieles;
> *Kein Lebendiges ist Eins*
> *Immer ist's ein Vieles.*

Herder, in speaking of the works of the Creator, says: "Every one of Thy works Thou makest *one* and perfect, and like itself alone."

This sentence presents the other aspect of existence, by which the multiform is one; and every unity in the one-sidedness and incompleteness of all single manifestations, is after all a perfect whole. These words lead us to the internal essence of things, referring us at the same time to the primary ideas, which Nature comprehends and realizes in Life.

(*To be continued.*)

ART. XXXII.—*A Research on Tellurmethyle;* by F. WÖHLER and J. DEAN.

(Read before the American Academy of Arts and Sciences, by Prof. Horsford.)

IT was not difficult to foresee that a compound of tellurium would be formed with the radical of methylic alcohol after the corresponding ethyle compound had been described. In this little research which we propose to offer in the following pages, we only desire the credit of having made the first step, and of having overcome the difficulties which are inseparably connected with the investigation of a body possessing such an excessively disgusting odor.

The preparation of tellurmethyle is conducted in a manner exactly similar to that employed for obtaining tellurethyle;* namely, by distilling telluret of potassium with a moderately con-

* Abhandl. der k. Gesell. der Wissenschaft zu Göttingen. B. vi.—Ann. Ch. Pharm., lxxxiv, 69.

centrated solution of sulphomethylate of baryta. The reaction goes on very easily of its own accord, very little heat being required, and the distillation is continued as long as oil drops are seen to go over with the water.

Tellurmethyle is a pale clear yellow, oily, very mobile liquid, heavier than water with which it is not miscible. Its smell is extremely disagreeable, resembling garlic, very intense, and enduring so long that the breath itself smells strongly after working with it for any length of time. Its boiling point we found to be about 82° C.* Its gas is yellow, like that of tellurium itself.

Exposed to the air it smokes feebly in consequence of oxydation. Set on fire it burns with a clear, luminous, bluish white flame forming copious vapors of tellurous acid. Tellurmethyle, C_2H_3Te, behaves like tellurethyle, as a radical, or so to speak as a metal. It forms a basic oxyd and the corresponding haloid compounds. Its elementary analysis was considered superfluous, as its constitution can be safely determined from its compounds, which are also much easier to analyze.

Oxyd of Tellurmethyle—C_2H_3TeO.—This is formed when tellurmethyle is heated with somewhat strong nitric acid. At first it is partially dissolved imparting a reddish yellow color to the liquid, then there takes place a strong reaction, and we obtain a colorless solution of oxyd of tellurmethyle, nitrous oxyd gas being evolved. After careful evaporation, the salt is obtained in colorless, prismatic crystals†. It is easily soluble in water and in alcohol. By heating it is decomposed, flashing like gunpowder. It is the material for the formation of all the other compounds. We found however that the simplest method for preparing oxyd of tellurmethyle was not from this salt, but from the chlorine or iodine compounds, by decomposition with oxyd of silver. The compound was covered with a little water, and oxyd of silver freshly precipitated by means of baryta water, and well washed, was mixed with it in excess. The decomposition begins instantly and is attended by spontaneous warming of the mass. In the fluid filtered from the iodid or chlorid of silver, oxyd of tellurmethyle is contained in solution.

Oxyd of tellurmethyle is, when evaporated to dryness, indistinctly crystalline. Exposed to the air it evaporates, absorbing

* Very probably the boiling point should be stated at 80° C., for in the experiment the tellurmethyle itself was covered with a little water, and the thermometer was not plunged into this, but into oil, in which the very thin tube containing the tellurmethyle was placed and heated.

If we take 80° C., as the boiling point, according to the law laid down by *H. Kopp*, the boiling point of tellurmethyle, which is not yet determined by experiment would be about 99° C.

† Sometimes, probably either by the employment of too much or too strong an acid, we obtained by evaporation, not a crystalline salt, but a transparent, amorphous mass. In this case it contained, as it appeared, in consequence of the decomposition of a part of the methyle, tellurous acid, either merely as a mixture or in combination.

also carbonic acid. It has a disagreeable taste but is without smell. Its solution reacts strongly alkaline upon red litmus paper. It is so strong a base as to drive out ammonia, even at the common temperature, from sal-ammoniac; and gives with a solution of sulphate of copper a voluminous blueish precipitate. From its solution, sulphurous acid precipitates oily drops evolving the peculiar smell of tellurmethyle. Hydrochloric acid precipitates white chlorid of tellurmethyle, and hydriodic acid, the red iodid.

Sulphate of oxyd of tellurmethyle, is formed by the immediate saturation of the base with the acid; it crystallizes in transparent, somewhat large and regular cubes, is very soluble in water, but insoluble in alcohol. The other salts we were unable to form from lack of material; we could only observe that the salts of oxalic, tartaric, acetic and formic acids were very soluble.

Chlorid of Tellurmethyle—C_2H_3TeCl.—It is formed as a voluminous white precipitate, resembling chlorid of lead, when hydrochloric acid is added to a solution of the nitrate; by heating it is dissolved, and crystallizes by slowly cooling, in very beautiful, long prismatic needles, resembling chlorid of mercury. It melts at about $97^{\circ}\cdot5$ C., but appears not to be capable of being entirely melted without decomposition. Although it cannot be distilled over with water, its solution possesses a feeble smell of garlic. After being melted it becomes again quite crystalline. It is very soluble in alcohol. If prepared from a solution of the amorphous nitrate, it contains tellurous acid either in admixture or in combination. With bichlorid of platinum it gives no precipitate.

Oxychlorid of Tellurmethyle—$C_2H_3TeO + C_2H_3TeCl$.—This is formed by dissolving the chlorid in ammonia, after evaporating a mixture of chlorid of ammonium the oxychlorid is obtained. These can be easily separated by means of strong alcohol. The oxychlorid forms colorless short prisms. Hydrochloric acid precipitates from its solution the chlorid.

Bromid of Tellurmethyle—C_2H_3TeBr.—It is formed in the same way as the chlorid, which it very much resembles and with which it is perhaps isomorphous. It forms shining, colorless prisms and melts at 89° C.

Iodid of Tellurmethyle—C_2H_3TeI.—If colorelss hydriodic acid, or a solution of iodid of potassium is dropped into a solution of the nitrate or chlorid of tellurmethyle, a bright citron yellow precipitate is formed, which after a few moments changes to a vermilion color. If the solutions are mixed while still warm, the precipitate becomes immediately red and crystalline. After drying it forms a vermilion colored, crystalline powder. The iodid was used for determining the constitution of tellurmethyle. The carbon and hydrogen were estimated by combustion with oxyd of copper; the iodine by dissolving the compound in water and precipitation with nitrate of silver; the tellurium by decomposing the compound with aqua-regia, evaporating to dryness, redissolving and precipitating with sulphite of ammonia.

0·265 grm. gave 0·0525 grm. CO_2 and 0·0386 grm. HO.

0·2665 grm. gave 0·305 grm. AgI.

0·2721 grm. gave 0·085 grm. Te.

Or in 100 parts.			Found.
C_2	=	5·81	5·40
H_3		1·45	1·61
Te		31·12	31·24
I		61·62	61·54
		100·00	99·79

Iodid of tellurmethyle is but slightly soluble in cold water, much more so in warm; it dissolves in large quantity and imparts a reddish yellow color to alcohol. From both liquids it crystallizes in small, shining, vermilion colored prisms, which are largest when obtained from an alcoholic solution. They appear to be rhombic octahedrons. If the cold alcoholic solution is mixed with about an equal volume of water, the iodid is precipitated as a citron-yellow precipitate, but after a few moments, one sees in the fluid a disturbance, and soon the entire precipitate whilst still in suspension is changed into glittering, crystalline plates of a vermilion color. This body, like iodid of mercury, has two different states, one yellow and one red, connected probably in both cases with a dimorphous condition. All endeavors have failed so far to preserve and crystallize either in the yellow form. By spontaneous evaporation of the alcoholic solution in which it is certainly contained in the yellow form, red crystals are obtained, and it is not fusible without decomposition. At about 130° C. it is changed into black iodid of tellurium. A cyanogen compound we were not able to obtain; at least by dissolving oxyd of tellurmethyle in aqueous hydrocyanic acid: by evaporation the base remained unchanged.

There appears also to be a sulphur compound which we were unable to study farther from lack of material. If hydrosulphuric acid gas be conducted into a solution of the chlorid of tellurmethyle, a white flocculent precipitate is formed, which becomes soon yellow, giving when exposed to the air a most insupportable alliaceous smell. If the liquid is now distilled, there goes over with the water an excessively offensive, heavy, oily liquid of a reddish yellow color, which by oxydation with aqua-regia gives a precipitate of sulphate of baryta when treated with chlorid of barium.

If the solution of the oxyd of tellurmethyle is saturated with hydrosulphuric acid, a light, whitish cloudiness is produced; when distilled, sulphur is deposited, and a yellow oil goes over which appeared to be only reduced tellurmethyle.

ART. XXXIII.—*Memoir on Meteorites—A Description of five new Meteoric Irons, with some theoretical considerations on the origin of Meteorites based on their Physical and Chemical characters;* by J. LAWRENCE SMITH, M.D., Professor of Chemistry in the Medical Department of the University of Louisville.

(Read before the American Association for the Advancement of Science, April, 1854.)

(Continued from p. 163.)

Some Theoretical considerations connected with Meteorites.

UNDER this head no mention will be made of the phenomena accompanying the fall of meteorites, as their light, noise, bursting, and their black coating; which arise after the bodies have entered the atmosphere, and are brought about by its agency. This omission will affect in no way the theoretical views under consideration, and the introduction of these particulars would uselessly increase the length of this memoir.

The lessons to be learned from meteorites, both stony and metallic, are probably not as much appreciated as they ought to be; we are usually satisfied with an analysis of them and surmises as to their origin, without due consideration of their physical and chemical characters.

The great end of science is to generalize facts that are observed. Thus terrestrial gravitation has been extended to the solar system, and in fact to the whole universe. The astronomer by his discoveries only proves the universality of this one law of nature operating on matter; he has found no evidence that any other force pertaining to terrestrial matter displays itself in a similar manner in other spheres. However true and self-evident it may appear that all matter in space is under the same laws, be they those of gravitation, cohesion, chemical affinity, etc., it is none the less interesting to have the fact proved, and meteorites when looked upon as bringing these proofs acquire additional interest.

Meteorites studied in the way just mentioned, lead us to the inference that the materials of the earth are exact representatives of the materials of our system, for up to the present time, no element has been found in a meteorite that has not its counterpart on the earth; or if we are not warranted in making such a broad assumption, we certainly have the proof, as far as we may ever expect to get it, that materials of other portions of the universe are identical with those of our earth.

Meteorites also show that the *laws of crystallization* in bodies foreign to the earth, are the same as those affecting terrestrial matter, and in this connection we may instance pyroxene, olivine and chrome iron affording in their crystalline form angles identical with those of terrestrial origin.

But perhaps of all the interesting facts under this head developed by meteorites, is the universality of the laws of chemical affinity, or the truth, that all the laws of chemical combination and atomic constitution are to be equally well seen in extra-terestrial and terrestrial matter; so that were Dalton or Berzelius to seek for the atomic weights of iron, silica or magnesia they might learn them as well from meteoric minerals as from those taken from the bowels of the earth. The atomic constitution of meteoric anorthite or of pyroxene is the same as that which exists in our own rocks.

Keeping in view then the physical and chemical characters of meteorites, I propose to offer some theoretical considerations which to be fully appreciated must be followed step by step. These views are not offered, because they individually possess particular novelty; it is the manner in which they are combined, to which especial attention is called.

Physical Characteristics to be noted in Meteorites.—The first physical characteristic to be noted is their form. No masses of rock, however rudely detached from a quarry, or blasted from the side of a mountain, or ejected from the mouth of a volcano, would present more diversity of form than meteoric stones: they are rounded, cubical, oblong, jagged, flattened, and in fine they present a great variety of fantastic shapes. Now the fact of form I conceive to be a most important point for consideration in regard to the origin of these bodies; as the form alone is strong proof that the individual meteorites have not always been cosmical bodies, for had they been, their form must have been spherical or spheroidal; as this is not so it is reasonable to suppose that at one time or another, they must have constituted a part of some larger mass. But as this subject will be taken up again, I pass to another point—namely the crystalline structure; more especially that of the iron, and the complete separation in nodules, in the interior of the iron, of sulphuret and phosphuret of the metals constituting the mass. When this is properly examined, it is seen that these bodies must have been in a plastic state for a great length of time, for nothing else could have determined such crystallization as we see in the iron, and allow such perfect separation of sulphur and phosphorus from the great bulk of the metal, combining only with a limited portion to form particular minerals; and did we aim to imitate such separation by artificial processes, we could only hope to do it by retaining the iron in a plastic condition for a great length of time. Also, no other agent than fire can be conceived of by which this metal could be kept in the condition requisite for the separation.

If these facts with reference to the crystalline structure be admitted, the natural suggestion is that they could only have been thus heated while a part of some large body.

Another physical fact worthy of being noticed here, is the manner in which the metallic iron and stony parts are often interlaced and mixed, as in the Pallas and Atacama irons, where nickeliferous iron and olivine in nearly equal portions (by bulk) are intimately mixed, so that when the olivine is detached the iron resembles a very coarse sponge. This is an additional fact in proof of the great heat to which the meteorites must have been submitted, for with our present knowledge of physical laws, there is no other way in which we can conceive that such a mixture of iron and olivine could have been produced.

Other physical points might be noticed, but as they are familiar to all, and would add nothing to the theoretical considerations, they will be passed over.

Mineralogical and Chemical points to be noted in Meteorites.—The rocks or minerals of meteorites are not of a sedimentary character, not such as are produced by the action of water. This is obvious to any one who will examine these bodies. A mineralogist will also be struck with the thin dark-colored coating on the surface of the stony meteorites. The coating, in most, if not in all, instances is of atmospheric origin, being acquired after the meteorite enters the atmosphere, and as such, no fnrther notice will be taken of it; but I will proceed at once to notice the most interesting peculiarities under this head. First of all, metallic iron alloyed with more or less nickel and cobalt is of constant occurrence in meteorites,—with but three or four exceptions,—in some instances constituting the entire mass, at other times disseminated in fine particles through stony matter. The existence of this highly oxydizable mineral in its metallic condition is a positive indication of a scarcity, or total absence, of oxygen (in its gaseous state or in the form of water) in the locality from whence it came.

Another mineralogical character of significance is, that the stony portions of the meteorites resemble the older igneous rocks, and in even a more striking manner, the volcanic rocks belonging to various active and extinct volcanoes. It is useless to dwell on this fact, as it is one well known to all mineralogists who may have examined this matter, and none have given more especial attention to it than Rammelsberg who in a paper published in 1849, details his examination of a great variety of lavas, and traced the perfect parallelism between them and stony meteorites. He showed that the Juvenas stone has the same constitution as the Thjorsa lava of Heckla, both consisting substantially of augite and anorthite, even in nearly the same relative proportions; while the Chateau Renard and Nordhausen stones, have labradorite replacing the anorthite; and the Blansko, Chantonnay and Utrecht stones have oligoclase as the feldspar, and resemble the lavas of Ætna, Stromboli and the newer lavas of Heckla.

The inference to be drawn from the last character is very evident, it is highly significative of the igneous origin of these bodies, and of an igneous action similar to that now existing in our volcanoes.

Yet another point of resemblance to certain of our terrestrial igneous rocks is the presence of metallic iron, for lately Mr. Andrews has proved the existence of metallic iron in basaltic rocks, but this will not be insisted on, as the quantity of iron discovered in basaltic rocks is so minute as only to be detected by the most delicate means of investigation.

Ever since the labors of Howard in 1802, the chemical constitution of meteorites have attracted much attention, more especially the elements associated in the metallic portion, and although we find no new elements, still their association, so far as yet known, is peculiar to this class of bodies. Thus nickel is a constant associate of iron in meteorites, (if we except the Walke Co., Ala., and Oswego, N. Y., meteorites upon whose claims to meteoric origin there yet remains some doubt); and although cobalt and copper are mentioned only as occasional associates in my examination of near thirty known meteorites (in more than one-half of which these constituents were not mentioned), I have found both of the last mentioned metals as constantly as the nickel. With our more recent method of separating cobalt from nickel, very accurate and precise results can be obtained as relates to the cobalt; the copper exists always in so minute proportion that the most careful manipulation is required to separate it.

Another element frequently, but not always, mentioned as associated with the iron, is phosphorus. Here again my testing of thirty specimens lead me to a similar generalization concerning phosphorus, namely, that no meteoric iron is to be expected without it; my examination has extended as well to the metallic particles separated from the stony meteorites as to the meteoric irons proper. It may be even further stated that, in most instances, the phosphorus was traceable directly to the mineral Schreibersite.

These four elements then, Iron, Nickel, Cobalt and Phosphorus, I consider remarkably constant ingredients. First in the meteoric irons proper, and secondly in the metallic particles of the stony meteorites; there being only some three or four meteorites among hundreds that are known, in which they are not recognized.

As regards the combination of these elements, it is worthy of remark that no one of them is associated with oxygen, although all four of them have strong affinity for this element, and are never found (except copper) in the earth uncombined with it, except where some similar element (as sulphur, &c.) supplies its place.*

* The traces of iron found in basaltic rock already alluded to, forms too insignificant an exception to be insisted on.—J. L. S.

The inference of the absence of oxygen in a gaseous condition, or in water, is drawn from such substances as iron and nickel being in their metallic state, as has been just mentioned: but it must not be inferred that oxygen is absent in all forms at the place of origin of the meteorites; for the silica, magnesia, protoxyd of iron, &c., contain this element. The occurrence of one class of oxyds and not another would indicate a limited supply of the element oxygen, the more oxydizable elements as silicon, magnesium, &c., having appropriated it in preference to the iron.

Many other elements worthy of notice might be mentioned here, and some of them for aught we know may be constant ingredients, but in the absence of strong presumption at least on this head, they will be passed over, as those already mentioned suffice for the support of all theoretical views to be advanced.

I cannot, however, avoid calling attention to the presence of *carbon* in certain meteorites, for although its existence is denied by some chemists, it is nevertheless a fact that can be as easily established as the presence of the nickel. The interest to be attached to it, is due to the fact that it is so commonly regarded in the light of an organic element. It serves to strengthen the notion that carbon can be of pure mineral origin, for no one would be likely to suppose that the carbon found its way into a meteorite either directly or indirectly from an organic source.

Having thus noted the predominant physical, mineralogical and chemical characteristics of meteorites I pass on to the next head.

Marked points of similarity in the Constitution of Meteoric Stones.—Had this class of bodies not possessed certain properties distinguishing them from terrestrial minerals, much doubt would even now be entertained of their celestial origin, and various would be the explanations made even in those cases where the bodies were seen to fall and afterwards collected. Chemistry has entirely dissipated all doubts in the matter, and now, an examination in the laboratory of the chemist is entitled to more credit than evidence from any other source in pronouncing on the meteoric origin of a body. No question need be asked as to whether it was seen to fall, or whether this or that rock or mineral exists in the neighborhood where it may have been collected. The reagents of the chemist alone are unerring indications that suffice to set aside all caviling in the matter.

It is the object of this part of the paper to explain more prominently perhaps than has yet been done, how it is that chemistry pronounces with such unerring certainty on the celestial origin of certain bodies; and I propose to go even a step farther, and see if the chemical constitution of the meteorites can indicate from what part of the heavens they may have come.

When the mineralogical and chemical composition of these bodies are regarded, the most ordinary observer will be struck with the wonderful family likeness running through them all, however unlike at first sight. There will be seen to be three great divisions of meteoric bodies (omitting three or four), namely —metallic ; stony with small particles of metal ; and a mixture of metallic and stony in which the former predominates, as in the Pallas and Atacama meteorites.

As regards external appearances, these three classes differ in a very marked manner from each other. The *meteoric iron* being ordinarily of a compact structure, more or less corroded externally, and when cut showing a dense structure with most of the peculiarities of pure iron, only a little harder in texture and whiter in color. The *stony meteorites* are usually of a grey or greenish grey color, granular structure, readily broken by a blow of the hammer, and exteriorly are covered with a thin coating of fused material. The *mixed meteorite* presents characters of both of the above ; a large portion of it is constituted of the kind of iron already mentioned, cellular in its character, and the cells filled up with stony materials, similar in appearance to those constituting the second class.

Although there are some instances of bodies of undoubted meteoric origin not properly falling under either of the above three heads, still they will be seen upon close investigation not to interfere in any way with the general conclusions that are attempted to be arrived at ; for these constituents are represented in the stony materials of the second class from which their only essential difference consists in the absence of metallic particles.

If we now examine chemically the three classes mentioned, we find them all possessed of certain common characteristics that link them together and at the same time separate them from every thing terrestrial. Take first the metallic masses : and in very many instances, in some fissure or cavity, exposed by sawing or otherwise, stony materials will frequently be found, and a stony crystal is sometimes exposed ; now examine the composition of these, and then compare the results with what may be known of the stony meteorites, and in every instance, it will agree with some mineral or minerals found in this latter class, as olivine or pyroxene, most commonly the former ; but in no instance is it a mineral not found in the stony meteorites. If these last, in their turn, be examined, differing vastly in their appearance from the metallic meteorites, they will with but two or three exceptions be found to contain a malleable metal identical in composition with the metal constituting the metallic meteorites.

As to those mixed meteorites in which the metallic and stony portions seem to be equally distributed ; their two elements are but representatives of the two classes just described. Examined in this way there will be no difficulty in tracing the same signature on them all, endorsing the above as their true character, and almost serving to tell us whence they came. They may emphatically be said to have been linked in their origin by a chain of iron.

There is one mineral which there is every reason to believe constantly accompanies the metallic portions, and which may be regarded as a most peculiar mark of difference between meteorites and terrestrial bodies. It is the mineral *Schreibersite* (see first part of this memoir) to which the constant presence of phosphorus in meteoric iron is due. This mineral as already remarked has no parallel on the face of the globe, whether we consider its specific or generic character, there being no such thing as phosphuret of iron and nickel or any other phosphuret found among minerals. These facts render the consideration of Schreibersite one of much interest, running as it probably does through all meteorites, and forming another point of separation between meteorites and terrestrial objects.

Another striking similarity in the composition of meteorites is the limited action of oxygen on them. In the case of the purely metallic meteorites we trace an almost total absence of this element. In the stony meteorites, the oxygen is in combination with silicon, magnesium, &c., forming silica, magnesia, &c., that combine with small portions of other substances to form the predominant earthy minerals of meteorites. When iron is found in combination with oxygen, it is found in its lowest state of oxydation as in the protoxyd of the olivine and chrome iron, and as magnetic oxyd.

Without going further into detail as regards the similarity of composition of meteorites, they will be seen to have as strongly marked points of resemblance as minerals coming from the same mountain, I might almost say from the same mine, and it is not asking much to admit their having a *common centre of origin* and that whatever the body from which they originate, it must contain no uncombined oxygen and I might even add none in the form of water.

What is this centre of origin? Physics does not point it out, and although the chemist cannot explore the elementary constitution of any other great celestial bodies than the earth, he can examine those smaller celestial masses which come to the earth and from his results stand on a firmer basis for theoretical conclusions.

Origin of Meteoric Stones.—In taking up the theoretical considerations of the origin of meteoric stones, it is of the utmost consequence, to reflect well before we confound shooting stars and meteoric stones as all belonging to the same class of bodies; a view entertained by many distinguished observers. It is doubtless owing to the fact of their having been confounded that but little advance has been made in settling upon the origin of these bodies; in fact, owing to this manner of viewing the subject, observers such as Arago, Bissel, Olbers and others have turned away from the original conception of the origin of meteoric stones to views of a different character based on observations of the shooting stars.

It may be a broad assumption to start with, that there is not a single evidence of the identity of shooting stars (as exemplified by the periodical meteors of August and November) and these meteors which give rise to meteoric stones, and this conclusion is one arrived at by as full an examination of the subject as I am capable of making.* Some of the prominent reasons for such a conclusion will be mentioned.

Were shooting stars and meteoric stones the same class of bodies, it is natural to suppose that the fall of the latter would be most abundant when the former are most numerous. In other words these periodic occurrences of shooting stars in August and November and more particularly those immense showers that have been sometimes seen, ought to have been attended with the falling of one or more meteoric stones; whereas there is not a single instance on record where these showers have been accompanied with the falling of a meteoric stone. Again, in all instances where a meteoric body has been seen to fall and has been observed even from its very commencement, it has been alone and not accompanied by other meteors. Very little reflection will serve to convince any one that an objection to the identity of the two classes of bodies based upon the above fact is of great weight.

Another strong objection to considering the bodies of the same nature, is based on the want of proof of their velocities being the same. It is a pretty well established fact that the average velocity of shooting stars is 16½ miles a second, a result arrived at by different observers, and doubtless a close approximation to the truth, as from the constant occurrence of shooting stars, thousands of observations may be made with comparative ease by different observers noting the same stars: not so with meteoric stones, these occurrences being rare, sudden and unexpected, and no two observers being ever prepared to note the data requisite for calculating their velocities; besides I am prepared to prove that the two or three cases of supposed determination of velocities of meteoric stones cannot be considered even gross approximation to the truth: in fact the difficulties in the way are so great that we probably never shall arrive at a knowledge of their

* Prof. D. Olmsted in a most interesting article on the subject of meteors, to be found in the 26th volume of the Am. Journal of Science, p. 132, insists upon the difference between shooting stars and meteorites, and the time and attention he has devoted to the phenomena of meteors give weight to his opinion.

velocities.* Not even their effect on striking the earth, will furnish any data whereby to calculate their velocities before entering the atmosphere, for this medium must offer such enormous resistance to bodies penetrating at great velocities, that these velocities must be reduced to but a fraction of what they originally were, and it is a question whether a body entering our atmosphere at ten miles a second would penetrate the soil to a much greater depth than one entering it at five miles a second, for the increased velocity of the former would cause an increased resistance in the atmosphere and therefore have received proportionally a greater check before striking the earth.

Another fact tending to prove a dissimilarity between shooting stars and meteoric stones, is that the velocity of no one of the shooting stars has been observed to be so low as to allow of their being considered satellites to the earth; their average velocity is 16½ miles a second and it requires a reduction to less than six miles a second for them to assume a path around the earth. Now, assume what we may as to the original orbit of the meteoric stones, and as to their original velocity—let their orbit be around the sun and their velocity 16 miles a second—there is one thing we know, namely that these bodies do enter our atmosphere, and it is but right to assume, often pass through the atmosphere without falling to the earth, sometimes passing through the very uppermost portion of that medium, at other times lower. What becomes of their original assumed velocity after this passage? As it can be so checked as to be drawn to the earth's surface, and thus stopped altogether in its passage, their velocities may be changed to any velocity from 16 miles a second to zero, according to the amount of resistance it meets with; and what is equally true in this connection, is, that when the velocity falls below six miles a second (or thereabouts) they can no longer escape from the attraction of the earth and resume their solar orbit, but must revolve as a satellite around the earth until ultimately brought to its surface by repeated disturbances.

The deduction from the above fact, is as follows: that as the most correct observations have never given a velocity of less than

* Under this head I will merely note what is considered one of the best established cases of the determination of velocity of a meteoric stone—namely that of the Weston meteorite the velocity of which Dr. Bowditch estimated to "*exceed three miles a second.*" Mr. Herrick considers the velocity very much greater, and writes among other things what follows. "The length of its path from the observations made at Rutland, Vt., and at Weston was at least 107 miles. This space being divided by the duration of the flight as estimated by two observers, viz., 30 seconds, we have for the meteor's relative velocity about *three and a half miles a second.* The observations made at Wenham, Mass., are probably less exact in this respect and need not be mentioned here. An experienced observer, however intelligent, will give the time ten or even twenty fold too large. One not unversed in science who saw the meteor is confident it could not have been in sight as long as ten seconds." The above is given as a specimen of the uncertain data we are to proceed upon in estimating the velocity of meteoric stones.

nine miles a second to a shooting star, it is reasonable to suppose that none have ever entered our atmosphere, or what is perhaps still more reasonable, that the matter of which they are composed is as subtle as that of Encke's comet, and any contact with even the uppermost limit of the atmosphere, destroys their velocity and disperses the matter of which they are composed. Other grounds might be mentioned for supposing a difference between shooting stars and meteoric stones, and I have dwelt on it thus much because it is conceived of prime importance in pursuing the correct path that is to lead to the discovery (if it can be made) of their origin. It is also of no small value to the beautiful and probable theory of shooting stars that we should separate every thing from it that may tend to affect its plausibility.

Various theories have been devised to account for their origin. One is that they are small planetary bodies revolving around the sun, and that at times they become entangled in our atmosphere lose their orbital velocity by the resistance of the atmosphere and are finally attracted to the earth. They are also supposed to have been ejected from the volcanoes of the moon: and lastly they are considered as formed from particles floating in the atmosphere. The exact nature of this last theory, is understood by reading the views of Prof. C. U. Shepard, as expressed in an interesting report on meteorites published in 1848. The author* says—"The extra-terrestrial origin of meteoric stones and iron masses, seems likely to be more and more called in question with the advance of knowledge respecting such substances and as additions continue to be made to the connected sciences. Great electrical excitation is known to accompany volcanic eruptions, which may reasonably be supposed to occasion some chemical changes in the volcanic ashes ejected; these being wafted by the ascensional force of the eruption into the regions of the magneto-polar influence, may there undergo a species of magnetic analysis. The most highly magnetic elements, (iron, nickel, cobalt, chromium, &c.,) or compounds in which these predominate, would thereby be separated, and become suspended in the form of metallic dust, forming those columnar clouds so often illuminated in auroral displays, and whose position conforms to the direction of the dipping needle. While certain of the diamagnetic elements, (or combinations of them,) on the other hand, may under the control of the same force be collected into different masses, taking up a position at right angles to the former, (which Faraday has shown to be the fact in respect to such bodies,) and thus produce those more or less regular arches, transverse to the magnetic meridian, that are often recognized in the phenomena of the aurora borealis.

* I must in justice to Prof. Shepard say that since his paper was written he has informed me that he no longer entertains these views; and I would now omit the criticism of them did they not exist in his memoir uncontradicted and also were they not views still entertained by some.

"Any great disturbance of the forces maintaining these clouds of meteor-dust, like that produced by a magnetic storm, might lead to the precipitation of portions of the matter thus suspended. If the disturbance was confined to the magnetic dust, iron masses would fall; if to the diamagnetic dust, a non-ferruginous stone; if it should extend to both classes simultaneously, a blending of the two characters would ensue in the precipitate, and a rain of ordinary meteoric stones would take place.

"The occasional raining of meteorites might therefore on such a theory, be as much expected, as the ordinary deposition of moisture from the atmosphere. The former would originate in a mechanical elevation of volcanic ashes and in matter swept into the air by tornadoes, the latter from simple evaporation. In the one case, the matter is upheld by magneto-electric force; in the other, by the law of diffusion which regulates the blending of vapors and gases, and by temperature. A precipitation of metallic and earthy matter would happen on any reduction of the magnetic tension; one of rain, hail or snow, on a fall of temperature. The materials of both originate in our earth. In the one instance they are elevated but to a short distance from its surface, while in the other, they appear to penetrate beyond its farthest limits, and possibly to enter the inter-planetary space; in both cases, however, they are destined, through the operation of invariable laws, to return to their original repository."

This theory, coming as it does from one who is justly entitled to high consideration, from the fact of the special attention he has given to the subject of meteorites, may mislead, and for that reason objections will be advanced which will doubtless entirely set aside this notion of terrestrial origin, and to this end I would consider two fundamental principles of it. First of all it must be proved that terrestrial volcanoes contain all the varieties of matter found in the composition of meteoric bodies; there is no doubt that many of the varieties are ejected from volcanoes, as olivine, &c., but then the principal one, nickeliferous iron has never in a single instance been found in the lava or other matter coming from volcanoes although frequently sought for.

But the physical obstacles are a still more insuperable difficulty in the way of adopting this theory. In the first place it is considered a physical impossibility for tornadoes or other currents of air to waft matter, however impalpable, "beyond the farthest limits of the earth and possibly into interplanetary space." Again if magnetic and diamagnetic forces cause the particles to coalesce and form solid masses, by the cessation of those forces the bodies would crumble into powder. Another strong physical objection to the theory is, that as the consolidation of these masses is expected to take place in "magneto-polar regions" their fall should only be in those portions of the earth, for like rain and hail (to which the consolidation of these bodies are assimilated in this theory) they should fall perpendicularly or nearly so, from their points of condensation. And lastly (under the head of physical objections) how can bodies so formed be precipitated in such very oblique directions as many are known to have, and that too from East to West and not from the North.

We pass on to a concise statement of some of the chemical objections to this theory of atmospheric origin, and if possible, they are more insuperable than the last mentioned. Contemplate for a moment the first meteorite described in this paper;—here is a mass of iron of about sixty pounds of a most solid structure, highly crystalline, composed of nickel and iron chemically united, containing in its centre a crystalline phosphuret of iron and nickel, and on its exterior surface a compound of sulphur and iron also in atomic proportions, and then see if the mind can be satisfied in supposing that the dust wafted from the crater of a volcano into the higher regions of the atmosphere, could *in a few moments of time* be brought together by any known forces so as to create the body in question. However finely divided this volcanic dust might be, it can never be subdivided into atoms, a state of things that must exist to form bodies in atomic proportions, where no agency is present to dissolve or fuse the particles concerned. One other objection and I am done with this theory.

The particles of iron and nickel supposed to be ejected from the volcano, must pass from the heated mouth of a crater ascend through the oxygen of the atmosphere without undergoing the slightest oxydation, for if there be any one thing which marks the meteorites more strongly than any other it is the freedom of the masses of iron from oxydation except on the surface. But a still more remarkable abstinence from oxydation would be the ascent of the particles of phosphorus to form the Schreibersite traceable in so many meteorites.

Having noticed the prominent objections to this theory I pass on to consider in as few words as possible the other two theories.

A very commonly adopted theory of the origin of meteoric bodies, is that they are small planetary bodies revolving around the sun, one portion of their orbit approaching or crossing that of the earth, and from the various disturbing causes to which these small bodies must necessarily be subjected, their orbits are constantly undergoing more or less variation, until intersected by our atmosphere when they meet with the most serious derangement and fall to the earth's surface in whole or in part; this may not occur in their first passage through the atmosphere, but repeated obstructions in this medium at different times must ultimately bring about the result. In this theory their origin is supposed to be the same as that of other planetary bodies, and they are regarded as always having had an individual cosmical existence. Now, however reasonable the admission of this orbital motion immediately before and for some time previous to their contact with the earth, the assumption of their original cosmical origin would appear to have no support in the many characteristics of meteoric bodies as enumerated some pages back. The form alone of these bodies is any thing but what ought to be expected from a gradual condensation and consolidation; all the chemical and mineralogical characters are opposed to this supposition. If the advocates of this theory do not insist on the last feature of it, then the theory amounts to but little else than a statement that meteoric stones fall to us from space while having an orbital motion. In order to entitle this planetary theory to any weight it must be shown, how, bodies formed and constructed as these are, could be other than fragments of some very much larger mass.

As to the existence of meteoric stones in space, travelling in a special orbit prior to their fall, there can be but little doubt when we consider their direction and velocity; their composition proving them to be of extra-terrestrial origin. This, however, only conducts in part to their origin, and those who will examine them chemically will feel convinced that the earth is not the first great mass that meteoric stones have been in contact with, and this conviction is strengthened when we reflect on the strong marks of community of origin so fully dwelt upon.

It is then in consideration of what was the connection of these bodies prior to their having an independent motion of their own that this memoir will be concluded.

Lunar Origin of Meteoric Stones.—It only remains to bring forward the facts already developed, to prove the plausibility of this origin of meteorites.

It is a theory that was proposed as early as 1660 by an Italian philosopher, Terzago, and advanced by Olbers in 1795, without any knowledge of its having been before proposed; it was sustained by Laplace with all his mathematical skill from the time of its adoption to his death; it was also advocated on chemical grounds by Berzelius, whom I have no reason to believe ever changed his views in this matter, and to these we have to add the following distinguished mathematicians and philosophers: Biot, Brandes, Poisson, Quetelet, Arago and Benzenberg who have at one time or another advocated the Lunar origin of meteorites.

Some of the above astronomers abandoned the theory, among them Olbers and Arago, but they did not do so, from any supposed defect in it, but from adopting the assumption that shooting stars and meteorites were the same; and on studying the former and applying the phenomena attendant upon them to meteorites, the supposed lunar origin was no longer possible.

On referring to the able researches of Sears C. Walker on the periodical meteors of August and November (Trans. Am. Phil.

Soc., Jan., 1841), that astronomer makes the following remarks about Olbers's change of views. "In 1836, Olbers, the original proposer of the theory of 1795, being firmly convinced of the correctness of Brandes's estimate of the relative velocity of meteors, renounces his *selenic* theory, and adopts the *cosmical* theory as the only one which is adequate to explain the established facts before the public."

For reasons already stated, it appears wrong to assume the identity of meteorites and shooting stars, so that whatever difficulty the phenomena of shooting stars may have interposed in conceiving this or that to have been the origin of meteoric stones, it now no longer exists, and we are fully authorized in forming our conclusions concerning them to the utter disregard of the phenomena of shooting stars. Had Olbers viewed the matter in this light, he would doubtless have retained his original convictions, to which no material objection appears to have occurred to him for forty years.

It is not my object to enter upon all the points of plausibility of this assumed origin, or to meet all the objections which have been urged to it; for most of them have already been ably treated of. The object now, is simply to urge such points as have been developed in this memoir, that appear to give strength to the lunar theory; they may be summed up under the following heads:

1st. That all meteoric masses have a community of origin.

2nd. At one period they formed parts of some large body.

3d. They have all been subject to a more or less prolonged igneous action corresponding to that of terrestrial volcanoes.

4th. That their source must be deficient in oxygen.

5th. That their average specific gravity is about that of the moon.

From what has been said under the head of common characters of meteorites, it would appear far more singular that these bodies should have been formed separately from each other than that they should have at one time or another constituted parts of the same body; and from the character of their formation, that body should have been of great dimensions. Let us suppose all the known meteorites assembled in one mass, and regarded by the philosopher, mindful of our knowledge of chemical and physical laws. Would it be considered more rational to view them as the great representatives of some one body that had been broken into fragments, or as small specks of some vast body in space that at one period or another has cast them forth? The latter it seems to me is the only opinion that can be entertained in reviewing the facts of the case.

As regards the igneous character of the minerals composing meteorites, nothing remains to be added to what has already been said; in fact no mineralogist can dispute the great resemblance of these minerals to those of terrestrial volcanoes, they having only sufficient difference in association, to establish that although igneous they are extra-terrestrial. The source must also be deficient in oxygen either in a gaseous condition or combined as in water: the reasons for so thinking have been clearly stated as dependent upon the existence of *metallic iron* in meteorites; a metal so oxydizable, that in its terrestrial associations it is almost always found combined with oxygen and never in its metallic state.

What then is that body which is to claim common parentage of these celestial messengers that visit us from time to time? Are we to look at them as fragments of some shattered planet whose great representatives are the thirty-three asteroids between Mars and Jupiter and that they are "minute outriders of the asteroids" (to use the language of R. P. Greg, Jr., in a late communication to the British Association), which have been ultimately drawn from their path by the attraction of the earth? For more reasons than one this view is not tenable; many of our most distinguished astronomers do not regard the asteroids as fragments of a shattered planet, and it is hard to believe if they were, and the meteorites the smaller fragments, that these latter should resemble each other so closely in their composition; a circumstance that would not be realized if our earth was shattered into a million of masses large and small.

If then we leave the asteroids and look to the other planets we find nothing in their constitution, or the circumstances attending them, to lead to any rational supposition as to their being the original habitation of the class of bodies in question. This leaves us then but the *moon* to look to as the parent of meteorites, and the more I contemplate that body, the stronger does the conviction grow, that to it all these bodies originally belonged.

It cannot be doubted from what we know of the moon that it is in all likelihood constituted of such matter as compose meteoric stones; and that its appearances indicate volcanic action, which when compared with the combined volcanic action on the face of the globe, is like contrasting Ætna with an ordinary forge, so great is the difference. The results of volcanic throws and outbursts of lava are seen, for which we seek in vain any thing but a faint picture on the surface of our earth. Again in the support of the present view it is clearly established that there is neither atmosphere nor water on the surface of that body, and consequently no oxygen in those conditions which would preclude the existence of metallic iron.

Another ground in support of this view is based on the specific gravity of meteorites, a circumstance that has not been insisted on, and although of itself possessing no great value, yet in conjunction with the other facts it has some weight.

In viewing the cosmical bodies of our system with relation to their densities, they are divided into two great classes—planetary and cometary bodies (these last embracing comets proper and shooting stars), the former being of dense, and the latter of very attenuated matter; and so far as our knowledge extends, there is no reason to believe that the density of any comet approaches that of any of the planets: this fact gives some grounds for connecting meteorites with the planets. Among the planets there is also a difference, and a very marked one, in their respective densities; Saturn having a density of 0·77 to 0·75, water being 1·0; Jupiter 2·00–2·25; Mars 3·5–4·1; Venus 4·8–5·4; Mercury between 7 and 36; Uranus 0·8–2·9; that of the Earth being 5·67.* If then from specific gravity we are to connect meteorites to the planets, as their mean density is usually considered about 3·0,† they must come within the planetary range of Mars, Earth and Venus. In the cases of the first and last we can trace no connection, from our ignorance of their nature and of the causes that could have detached them.

This reduces us then to our own planet consisting of two parts, the planet proper with a density of 5·76, and the moon with a density of about 3·62.‡ On viewing this, we are at once struck with the relation that these bear to the density of meteorites, a relation that even the planets do not bear to each other.

As before remarked, I lay no great weight on this view of the density, but call attention to it as agreeing with conclusions arrived at on other grounds.

The chemical composition is also another strong ground in favor of their lunar origin. This has been so ably insisted on by Berzelius and others that it would be superfluous to attempt to argue the matter any further here; but I will simply make a comment on the disregard that astronomers usually have for this argument. In the memoir on the periodic meteors by Sears C. Walker, already quoted from, it is stated, "The chemical objection is not very weighty, for we may as well suppose a uniformity of constituents in cosmical as in lunar substances." From this conclusion it is reasonable to dissent, for as yet we are acquainted with the materials of but two bodies, those of the earth and those of meteorites, and their very dissimilarity of consti-

* For these estimates of the densities of the Planets, the author is indebted to Prof. Peirce.

† Although the average specific gravity of the metallic and stony meteorites is greater, yet the latter exceeding the former in quantity, the number 3·0 is doubtless as nearly correct as can be ascertained.

‡ Although the densities of the earth and moon differ, these two bodies may consist of similar materials, for the numbers given represent the density of bodies as wholes; the solid crust of the earth for a mile in depth cannot average a density of 3·0.

tution is the strongest argument of their belonging to different spheres. In further refutation of this idea it may be asked, Is it to be expected that a mass of matter detached from Jupiter (a planet but little heavier than water) or from Saturn (one nearly as light as cork) or from Encke's comet (thinner than air), would at all accord with each other or with those of the earth. It is far more rational to suppose that every cosmical body, without necessarily possessing elements different from each other, yet are so constituted that they may be known by their fragments. With this view of the matter, our specimens of meteorites are but multiplied samples of the same body, and that body, with the light we now have, appears to have been the moon.

This theory is not usually opposed on the ground that the moon is not able to supply such bodies as the meteoric iron and stone; it is more commonly objected to from the difficulty that there appears to be in the way of this body's projecting masses of matter beyond the central point of attraction between the earth and moon. Suffice it to say, that Laplace, with all his mathematical acumen, saw no difficulty in the way of this taking place, although we know, that he gave special attention to it at three different times during a period of thirty years, and died without discovering any physical difficulty in the way. Also for a period of forty years, Olbers was of the same opinion, and changed his views as already stated for reasons of a different character: and to these two we add Hutton, Biot, Poisson and others whose names have been already mentioned.

Laplace's view of the matter was connected with present volcanic action in the moon, but there is every reason to believe that all such action has long since ceased in the moon. This, however, does not invalidate this theory in the least, for the force of projection and modified attraction to which the detached masses were subjected, only gave them new and independent orbits around the earth, that may endure for a great length of time before coming in contact with the earth.

The various astronomers cited concur in the opinion, that a body projected from the moon with a velocity of about eight thousand feet per second would go beyond the mutual point of attraction between the earth and moon, and already having an orbital velocity may become a satellite of the earth with a modified orbit.

The important question then for consideration is, the force requisite to produce this velocity. The force exercised in terrestrial volcanoes varies. According to Dr. Peters, who made observations on Ætna, the velocity of some of the stones was 1250 feet a second, and observations made on the peak of Teneriffe gave 3000 feet a second. Assuming, however, the former velocity to be the maximum of terrestrial volcanic effects, the velocity with which the bodies started (stones with a specific gravity of about 3·00) must have exceeded 2000 feet a second to permit of an absorbed velocity of 1250 feet through the denser portions of our atmosphere. Now suppose the force of the extinct volcanoes of the moon to have equalled that of Ætna, the force would have been more than sufficient to have projected masses of matter at a velocity exceeding 8000 feet a second; for, the resistance to be overcome by the projectile force, is the attractive force of the moon, which is from 5 to 6 times less than that of the earth, so that the same projectile force in the two bodies would produce vastly greater velocities on the moon than on the earth, discarding of course atmospheric resistance of which there is none in the moon.*

But doubtless, were the truth of the matter known, the projectile force of lunar volcanoes far exceeded that of any terrestrial volcanoes extinct or recent, and this we infer from the enormous craters of elevation to be seen upon its surface, and their great elevation above the general surface of the moon, with their borders thousands of feet above their centre; all of which, point to the immense internal force required to elevate the melted lava that must have at one time poured from their sides. I know that Prof. Dana in a learned paper on the subject of lunar volcanoes (Am. J. Sci., [2], ii, 375, argues that the great breadth of the craters is no evidence of great projectile force, the pits being regarded as boiling craters where force for lofty projection could not accumulate. Although his hypothesis is ingeniously sustained, still, until stronger proof is urged, we are justified I think in asuming the contrary to be true, for we must not measure the convulsive throes of nature at all periods by what our limited experience has enabled us to witness.

As regards the existence of volcanic action in the moon without air or water, I have nothing at present to do, particularly as those who have studied volcanic action concede that neither of these agents is absolutely required to produce it; moreover, the surface of the moon is the strongest evidence we have in favor of its occurring under those circumstances.

But it may be very reasonably asked, Why consider the moon the source of these fragmentary masses called meteorites? May not smaller bodies, either planets or satellites, as they pass by the earth and through our atmosphere, have portions detached by the mechanical and chemical action to which they are subjected? To this, I will assent, as soon as the existence of that body or those bodies is proved. Are we to suppose that each meteorite falling to the earth is thrown off from a different sphere

* It would require at the moon the same force to produce an *initial* velocity of 8000 feet a second as at the earth; and the difference of rate at the end of the first second would be slight (discarding from consideration the atmosphere).—Eds.

which becomes entangled in the atmosphere? If so, how great the wonder that the earth has never intercepted one of those spheres, and that all should have struck the stratum of air surrounding our globe (some fifty miles in height) and escaped the body of the globe 8000 miles in diameter. It is said that the earth has never intercepted one of these spheres; for if we collect together all the known meteorites, in and out of cabinets, they would hardly cover the surface of a good sized room, and no one of them could be looked upon as the maternal mass upon which we might suppose the others to have been grafted; and this would appear equally true, if we consider the known meteorites as representing not more than a hundredth part of those which have fallen.

If it be conceived that the same body has given rise to them, and is still wending its path through space, only seeming by its repeated shocks with our atmosphere to acquire new vigor for a new encounter with that medium, the wonder will be greater, that it has not long since encountered the solid part of the globe; but still more strange, that its velocity has not been long since destroyed by the resistance of the atmosphere, through which, it must have made repeated crossings of over 1000 miles in extent.

But it may be said that facts are stronger than arguments, and that bodies of great dimensions (even over one mile in diameter) have been seen traversing the atmosphere, and have also been seen to project fragments and pass on. Now of the few instances of the supposed large bodies, I will only analyze the value of the data upon which the Wilton and Weston meteorites were calculated; and they are selected, because the details connected with them are more accessible. The calculations concerning the latter were made by Dr. Bowditch; but his able calculations were based on deceptive data,—and this is stated without hesitation knowing the difficulty admitted by all of making correct observation as to size of luminous bodies passing rapidly through the atmosphere. Experiments, that would be considered superfluous, have been instituted to prove the perfect fallacy of making any but a most erroneous estimate of the size of luminous bodies, by their apparent size, *even when their distance from the observer and the true size of the object are known;* how much more fallacious then, any estimate of size made, where the observer does not know the true size of the body, and not even his distance very accurately.

In my experiments, three solid bodies in a state of vigorous incandescence were used; 1st, charcoal points transmitting electricity; 2nd, lime heated by the oxy-hydrogen blowpipe; 3d, steel in a state of incandescence in a stream of oxygen gas. They were observed on a clear night at different distances, and the body of light (without the bordering rays) compared with the disk of the moon, then nearly full, and 45° above the horizon. Without going into details of the experiment the results will be tabulated,

	Actual diam. as seen at 10 in.	Apparent diam. at 200 yds.	Apparent diam. at $\frac{1}{4}$ mile.	Apparent diam. at $\frac{1}{2}$ mile.
Carbon points,	$\frac{3}{10}$ of an inch,	$\frac{1}{2}$ the diam. moon's disk,	3 diam. do. do.	$-3\frac{1}{2}$ diam. do. do
Lime light,	$\frac{4}{10}$ " "	$\frac{1}{3}$ " " " "	2 " "	2 " "
Incandes. steel,	$\frac{2}{10}$ " "	$\frac{1}{4}$ " " " "	1 " "	1 " "

If then the apparent diameter of a luminous meteor at a given distance is to be accepted as a guide for calculating the real size of these bodies the

Charcoal* points	would be 80 feet in diam.	instead of $\frac{3}{10}$	of an inch.
Lime	" " 50 " "	"	$\frac{4}{10}$ "
The steel globule	" " 25 " "	"	$\frac{2}{10}$ "

It is not in place to enter into any explanation of these deceptive appearances, for they are well known facts, and were tried in the present form only to give precision to the criticism on the supposed size of these bodies. Comments on them are also unnecessary, as they speak for themselves. But to return to the two meteorites under review.

That of Wilton was estimated by Mr. Edward C. Herrick, (Am. Journ. of Science, vol. xxxvii, p. 130) to be about 150 feet in diameter. It appeared to increase gradually in size until *just before the explosion*, when it was at its largest apparent magnitude of ¼th the moon's disk—exploded 25° to 30° above the horizon with a heavy report, that was heard about 30 seconds after the explosion was seen. One or more of the obervers saw luminous fragments descend toward the ground. When it exploded, it was three or four miles above the surface of the earth; immediately after the explosion, it was no longer visible. The large size of the body is made out of the fact of its appearing one-fourth the apparent disk of the moon at about six miles distant. After the experiments just recorded, and easy of repetition, the uncertainty of such a conclusion must be evident; and it is insisted on as a fact easy of demonstration, that a body in a state of incandescence, (as the ferruginous portions of a stony meteorite,) might exhibit the apparent diameter of the Wilton meteorite at six miles distance, and not be more than a few inches or a foot or two in diameter according to the intensity of the incandescence.†

Besides, if that body was so large, where did it go to after throwing off the supposed small fragments? The fragments were

* Estimate made according to a table given by Prof. Olmsted (Am. Journal of Science, vol. xxvi, p. 155) for estimating the diameter of meteors on comparison with the moon.

† It ought however to be stated, that in the paper above referred to, Mr. Herrick expressly mentioned this and other sources of fallacy, endeavored as far as practicable to guard against them, and gave his final careful result as necessarily open to some uncertainty.—Eds.

seen to fall, but the great ignited mass suddenly disappeared, at 30° above the horizon, four miles from the earth, when it could not have had less than six or seven hundred miles of atmosphere to traverse, before it reached the limit of that medium; it has already acquired a state of ignition in its passage through the air prior to the explosion, and should have retained its luminous appearence consequent thereupon, at least while remaining in the atmosphere: but as this was not the case, and a sudden disappearance of the entire body took place in the very lowest portions of the atmosphere, and descending luminous fragments were seen, the natural conclusion appears to be, that the whole meteorite was contained in the fragments that fell.

As to the Weston meteorite, it is stated that its direction was nearly parallel to the surface of the earth at an elevation of about 18 miles; was one mile farther when it exploded; the length of its path from the time it was seen until it exploded was at least 107 miles; duration of flight estimated at about 30 seconds, and its relative velocity three and a half miles a second; it exploded; three heavy reports were heard; *the meteorite disappeared at the time of the explosion.*

As to the value of the data upon which its size was estimated, the same objection is urged as in the case of the Wilton meteorite; and it is hazarding nothing to state that the apparent size may have been due to an incandescent body a foot or two in diameter. Also, with reference to its disappearance, there is the same inexplicable mystery. It is supposed from its enormous size that but minute fragments of it fell; yet it disappeared at the time that this took place, which it is supposed occurred 19 miles above the earth, (an estimate doubtless too great when we consider the heavy reports). Accepting this elevation, what do we have? A body one mile and a half in diameter in a state of incandescence, passing in a curve almost parallel to the earth, and while in the very densest stratum of air that it reaches with a vigorous reaction between the atmosphere and its surface, and a dense body of air in front of it, is totally eclipsed; while, if it had a direction only tangential to the earth, instead of nearly parallel, it would at the height of 19 miles have had upwards of 500 miles of air of variable density to traverse, which at the relative velocity of 3½ miles a second (that must have been constantly diminishing by the resistance) would have taken about 143 seconds. It seems most probable that if this body was such an enormous one, that it should have been seen for more than ten minutes after the explosion, for the reasons above stated. The fact of its disappearance at the time of the explosion, is strong proof that the mass itself was broken to fragments, and that these fragments fell to the earth;—assuring us that the meteorite was not the huge body represented, but simply one of those irregular stony fragments which, by explosion from heat and great friction against the atmosphere, become shattered. I say irregular, because we have strong evidence of this irregularity in its motion, which was "scolloping," a motion frequently observed in meteorites, and doubtless due to the resistance of the atmosphere upon the irregular mass, for a spherical body passing through a resisting medium at great velocity would not show this. In fact, if almost any of the specimens of meteorites in our cabinets were discharged from a cannon, even in their limited flight the scolloping motion would be seen.

This then will conclude what I have to say in contradiction to the supposition of large solid cosmical bodies passing through the atmosphere, and dropping small portions of their mass. The contradiction is seen to be based; first, upon the fact that no meteorite is known of any very great size, none larger than the granite balls to be found at the Dardanelles along side of the pieces of ordnance from which they are discharged; secondly, on the fallacy of estimating the actual size of these bodies from their apparent size; and lastly from its being opposed to all the laws of chance that these bodies should have been passing through an atmosphere for ages and none have yet encountered the body of the earth.

To sum up the theory of the lunar origin of meteorites, it may be stated—*That the moon is the only large body in space of which we have any knowledge, possessing the requisite conditions demanded by the physical and chemical properties of meteorites; and that they have been thrown off from that body by volcanic action, (doubtless long since extinct,) and, encountering no gaseous medium of resistance, reached such a distance as that the moon exercised no longer a preponderating attraction—the detached fragment, possessing an orbital motion and an orbital velocity, which it had in common with all parts of the moon, but now more or less modified by the projectile force and new condition of attraction in which it was placed with reference to the earth, acquired an independent orbit more or less elliptical. This orbit, necessarily subject to great disturbing influences may sooner or later cross our atmosphere and be intercepted by the body of the globe.*

In concluding this lengthy examination, I must say that a discussion of the phenomena accompanying the falling of meteorites has been avoided, as well as many points connected with their history. This has been done from its having no immediate connection with the object of this memoir, which is intended simply to present to the Association some new views, and many old views in a new light, so as to awaken attention to the study of this most interesting class of bodies.

ART. XXXIV.—*On the Variable Star Algol, or β Persei;* by FR. ARGELANDER.*

ALGOL, or *β Persei*, is unquestionably one of the most remarkable of all the variable stars, on account of the shortness of its period, in general, and especially the short time during which it continues at its minimum,—on account of the comparative precision with which this minimum may be determined,—and the regularity with which the star goes through its period. This regularity is so great that Wurm, even in the year 1819, that is to say, thirty-six years after Goodricke had discovered the periodicity of the variation of light in *Algol*, was able to represent all the observations by a uniform period, and did not venture to decide whether this period had become longer or shorter.† Nevertheless, the values of the duration of a period computed by himself at various epochs, indicate the former of these alternatives. From the earlier observations, comprising a series of 16 months, he found the period to be $2^d\ 20^h\ 48^m\ 59^s$; after sixteen years of additional observations, he diminished the time by $0^s{\cdot}3$; and redetermined it after 36 years as $2^d\ 20^h\ 48^m\ 58^s{\cdot}5$. The diminution of the time indicated by these computations has been put beyond all doubt by modern observations, which have also shown that the amount of this diminution is not proportional to the time, but is continually growing larger and larger. A collation of the duration of the period, as obtained by combining the nearly contemporaneous observations and discussing these series according to the method of least squares, will show this very distinctly. If we assume as the principal epoch, that of the minimum which occured 1800, January 2, morning, Paris civil time, the first column of the following table of periods gives the number completed since this principal epoch; the second, the time; the third, the duration of the period which holds for this time, accompanied by the probable uncertainty of this latter determination.

Periods of Algol.

No. of minimum.	Date.	Length of period.	
		d. h. m. s.	s.
−1987	1784, May 27	2 20 48 59·42	± 0·32
−1405	1788, Dec. 21	58·74	± 0·09
− 825	1793, July 11	58·39	± 0·18
+ 751	1805, Nov. 25	58·45	± 0·04
+2328	1818, Apr. 13	58·19	± 0·10
+3885	1830, July 3	57·97	± 0·05
+5441	1842, Sept. 20	55·18	± 0·35
+6183	1848, July 18	53·37	± 0·08

A glance at this table shows immediately that the several observations can be represented neither by a uniform nor by a uniformly

* Copied from the Astronomical Journal, No. 80, January 1855.

† Bode's *Astronomisches Jahrbuch* for 1822, p. 120.

diminishing length of period. They might, however, be represented by having regard to the third and fourth power of the time; or, still better, by introducing a correction to a uniform period, which should progress according to sines and cosines in such a way that the p^{th} minimum after the epoch E would be given by the formula,

$$E + ap + b \sin (np + B) + c \sin (2np + C) + \ldots\ldots$$

But the endeavor to develop the constants, even taking account of the first term only in the series of sines, proves fruitless, owing to the insufficiency of the data; of which, indeed, we have a tolerable number for the last century, but which since then are so scarce, that for the first forty years of the present century I am only aware of 19 observed minima. In the last few years certainly the attention of astronomers has been again more directed to this remarkable phenomenon; but if we are soon to arrive at an accurate knowledge of the phenomenon itself, and of the rules according to which the period varies, the number of observers must be very considerably increased. Out of the 127 or 128 minima which occur in a year, there are scarcely 40 for which the requisite darkness, and a sufficient altitude of the star above the horizon, permit a trustworthy observation. Then deducting, not only the many days which are overcast, but those also on which flying clouds or mist disturb the observation, as well as those on which other pressing avocations prevent the astronomer from devoting his attention to the phenomenon, this number will be extraordinarily diminished. I have myself not yet succeeded in observing more than 8 minima in any one year, and then only in the year 1840, in which no more extended series of observations demanded my time. Under these circumstances, I take the liberty of earnestly entreating American astronomers to give their attention to this interesting phenomenon. Certainly some sacrifices are requisite for this, inasmuch as a complete observation demands not less than an hour and a half, during which the brilliancy of this star must be compared with that of others every 6^m or 8^m. For comparison-stars I use δ and ϱ *Persei*, and α and β *Trianguli*. The star ϱ *Persei* indeed is itself somewhat variable, but its period is longer, and it is especially favorable on account of its proximity to *Algol*, and because it is very nearly equal to this star when at its minimum. In a comparison of *Algol* with ϱ, the little variations from uniformity in the transparency of the air, which always exist to a greater or less degree, will exert the smallest possible influence.

Concerning the manner in which the comparative brilliancy of stars is to be observed without the aid of instruments, I have spoken in detail in another place;* and will here only briefly re-

* Schumacher's *Jahrbuch für* 1844, p. 191 et ff.

peat what I have there said. When the weather is misty, when clouds are flying, in bright twilight or too close vicinity to the moon, such observations should not be undertaken. It is especially important to avoid the impression of any other light, and, when the moon is up, to place one's self in such a position that the moon will be hid by some object. Before observing, the eye should be for some time accustomed to the darkness, in order that the pupil may be dilated as much as possible. Then look *alternately* at the two stars which are to be compared, and endeavor to receive the image on that part of the eye in which it is seen the brightest. On the other hand exercise the most zealous care not to look at both stars at once, for in such a case the two can never be seen at once in their full brightness. After the eye has thus been directed alternately to the one and to the other several times and a distinct judgment formed as to their relative brilliancy, write this down in figures. I denote a decided difference in the brightness of two stars by the expression "a grade,"—set down the differences of brightness as 2 grades when I can imagine a third between them, and of a brilliancy decidedly different from either,—as 3, when the difference is so great that two others can be thus interpolated in imagination between them; and so on. A greater difference than 4 grades I do not estimate, since this mode then becomes too unsafe; but do on the other hand, estimate half, and in some cases even quarter grades. In recording, the letter denoting the brighter star is first written down, then the number of grades, and last the letter of the fainter star. The precision which may be obtained in this way, after a little practice, is very considerable; the probable uncertainty amounts, for a single estimate, to about half a grade, and this is much diminished by comparing the star which is to be determined with many others, especially when some of these are brighter and others fainter.

As to the computation of the time of the minimum of *Algol* from the observations at hand, I do not content myself with putting for this the time of least brilliancy; but use for this purpose all the observations made for half an hour before and after the minimum, by taking the mean of the times at which *Algol* manifested the same difference of brightness from the comparison-stars during its decrease and increase of brilliancy, and then the mean of all these means, as the final result. Treated in this way, the observations afford remarkable precision, so that the probable error of an observed minimum does not amount to so much as 6 minutes, and discordances of a quater of an hour from the mean are extremely rare.

Since the number of observers has increased within a short time, a series of minima are available which have been independently determined by different observers, and, in part, at different places; thus affording a means of learning the real errors of observation. Since the autumn of last year I have collected 8 minima, which have been determined by several observers, the number of the several observations amounting to 33. From these 33 observations the probable uncertainty in the determination of a minimum by a single observer is deduced as $5^{m}\cdot625$. But during the same time there were, besides these, 9 other minima obtained from a single observer. These observations, 42 in all, I have, in order to be more independent of the length of the period, combined in two means, compared the several observations *singly* with these, and thus found the probable error of such an observation to be $5^{m}\cdot895$. This error is somewhat larger than the preceding; still the difference lies considerably within the limits of uncertainty of both determinations, and consequently cannot warrant us in inferring that the period is subject to irregular variations, but merely that, if such exist, they can only be extremely small. The assumption of such an irregularity, amounting to but little more than 1^{m}, would bring the two numbers into perfect agreement.

To make the agreement in the several results more clear, I will here give the 24 minima observed during this autumn and winter, after reducing them by assuming the period $2^{d}\ 20^{h}\ 48^{m}\ 53^{s}$, to one principal epoch, namely, the minimum of Oct. 8. The annexed table contains in the first column the number of periods elapsed since 1800, Jan. 2;—the second, the time as ob-

Minima of Algol.

No. minimum.	Observed Paris time.		Observer.	Equation of light.	Reduced time.	
		h. m. s.		m. s.		h. m. s.
6959	Aug. 20	11 28 27	A.	+ 0 27	Oct. 8	5 19 55
		11 30 27	Sd.			21 55
6966	Sept. 9	13 23 1	B.	+ 2 59		34 50
		13 25 3	K.			36 52
6967	Sept. 12	9 53 34	B.	+ 3 20		16 51
		10 2 23	Sd.			25 40
		10 15 9	A.			38 26
		10 16 54	O.			40 11
6973	Sept. 29	14 53 52	B.	+ 5 11		25 42
6974	Oct. 2	11 43 45	K.	+ 5 27		26 58
		11 46 3	A.			29 16
		11 46 4	B.			29 17
		11 58 12	N.			41 25
		12 0 44	O.			43 57
		12 1 52	Sd.			45 5
6981	Oct. 23	13 18 28	Sd.	+ 6 55		20 58
6983	Oct. 28	7 1 57	A.	+ 7 12		26 58
		7 7 39	K.			32 40
		7 11 30	H.			36 31
		7 18 48	N.			43 49
6989	Nov. 14	11 51 46	B.	+ 7 35		23 52
6997	Dec. 7	10 19 31	A.	+ 7 2		20 0
		10 23 10	Sd.			23 39
		10 25 31	K.		Oct. 8	5 26 0

served, reduced to mean Paris time by applying the difference of longitude;—the third indicates the observer; B. denoting Mr. Bruhns in Berlin; H., Prof. Heis in Münster; N., Dr. Nell in Manheim; O., Dr. Oudemans in Leyden; Sd., K., and A., Dr. Schönfield, Dr. Krüger and the author in Bonn. The fourth column contains the equation of light, and is that quantity which is to be added to the observed moment in order to correct it for the difference of time which, in the different distances of the stars from the earth, is required for the light to reach us. Finally, the fifth column gives the time, reduced to the principal epoch.

To obtain from these numbers the most probable result, we should not take the mean directly, but if a denote the probable irregularity of the period, and b the probable error of observation, each one of the n observations of the same minimum will receive the value $1:(na^2+b^2)$. But since, as we have already seen, a^2 is at any rate very small in comparison with b^2, and the number of observations yet too small to determine a with any degree of accuracy, the simple mean will still afford the most trustworthy result. This is, for the epoch 6976, Oct. 8, $5^h\ 30^m\ 27^s{\cdot}0$ M. T. Paris. The period might, according to the table already given, be assumed for the next year as about $2^d\ 20^h\ 48^m\ 51^s{\cdot}5$. But since the above result for Ep. 6976 compared with that which 18 observations furnish for Ep. 6870, namely, 1853, Dec. 8, $7^h\ 7^m\ 24^s{\cdot}6$ M. T. Paris, gives the decidedly longer period $2^d\ 20^h\ 48^m\ 53^s{\cdot}8 \pm 1^s{\cdot}04$, I have, in computing the following table of minima for the year 1855, combined the period $2^d\ 20^h\ 48^m\ 52^s$ with the epoch for 1854, Oct. 8. According to this, the first minimum of the year occurs Jan. 2, $0^h\ 38^m\ 57^s$ M. T. Washington, and the subsequent ones which occur in the hours of darkness, are stated below, and already corrected for the equation of light, so that the time for observation is directly given.

Minima of Algol visible in America, 1855.—Washington mean time.

		h.	m.			h.	m.			h.	m.			h.	m.			h.	m.			h.	m.
Jan.	7	18	12	Feb.	22	15	19	July	1	16	3	Aug.	22	6	37	Oct.	15	17	59	Nov.	30	15	0
	10	15	1		25	12	8		4	12	52	Sept.	2	17	49		18	14	48	Dec.	3	11	49
	13	11	50		28	8	57		7	9	41		5	14	38		21	11	36		6	8	38
	16	8	40	Mar.	17	13	54		24	14	31		8	11	27		24	8	25		9	5	27
	19	5	29		20	10	43		27	11	20		11	8	16	Nov.	7	16	29		20	16	43
	30	16	46		23	7	32		30	8	9		25	16	19		10	13	18		23	13	32
Feb.	2	13	35	Apr.	12	9	16	Aug.	13	16	11		28	13	7		13	10	7		26	10	21
	5	10	24	May	19	15	52		16	12	59	Oct.	1	9	56		16	6	56		29	7	1[illegible]
	8	7	13	June	11	14	22		19	9	48		4	6	45		27	18	11				

Bonn, 1854, December 9.

ART. XXXV.—*Supernumerary Tooth in Mastodon giganteus;* by JOHN C. WARREN, M.D.

THE jaw which contains this remarkable tooth was found in the autumn of 1854 at Terre Coupie in Michigan, while digging a cellar, at the depth of six feet from the surface, in a sandy deposit. Other portions of bone were discovered in the same place but not presenting anything remarkable. Fortunately it fell into the hands of an able geologist of Milwaukie, J. A. Lapham, Esq., who was competent to discover the peculiarity of the case. He wrote to me, gave some account of the bone, and being encouraged by my reply sent a description of it to the Boston Society of Natural History, which has been published, and afterwards procured the specimen for me.

The measurements of this jaw are as follows:

Length of right ramus on outer side, - -	26 in.
" " " " inner " - -	28 in.
" " dental surface, - - - -	16 in.
" " lower edge of jaw, - - -	22 in.
Distance from teeth to beak of symphysis, -	8 in.
Circumference of thickest portion of right ramus over ridges of penultimate tooth, - - - -	26¼ in.
Length of left symphysial portion,[1] - - -	8 in.

The number of the teeth is three. The first of these counting from before backwards has the form and magnitude of the fifth tooth in the lower jaw of the Mastodon giganteus. Its superior or coronal face is quadrangular, excavated on its middle portion from excessive use, its internal edge though much worn elevated compared to the external, which is more worn. The three ridges of the crown are nearly obliterated by wear, but we are able to discover the enamel which partially circumscribed each ridge. The whole of this surface has a beautiful smooth polished appearance of a dark color excepting the enamel ridge just spoken of. The fangs are, in number, two supporting the anterior ridge and united in one common mass, and four supporting the posterior ridges also united in a common mass. The extremities of the fangs are absorbed, so as to leave the tooth loose in its socket, and undoubtedly it would have been extruded had the animal lived sometime longer. There is no appearance of cavity in the fangs or body of the tooth, and the whole aspect is that of a tooth of great age, a portion of the anterior ridge being fairly worn away. The alveolar cavity is, however, separated into two parts by a ridge which divides it unequally, leaving one-third anterior for the anterior fangs, and two-thirds posterior for the posterior fangs. In the alveolus of the outer fang is found a portion of bone, which seems to have been broken from the extremity of this fang. This tooth is slightly penetrated by oxyd of iron, increasing its weight. It measures from before backwards over the centre of the grinding surface *four* inches; transverse width anteriorly *three* inches, posteriorly *three and a half* inches; inner edge antero-posteriorly *four and a half* inches; outer edge antero-posteriorly *three and a half* inches. The basal cingulum is more prominent on the outer than on the inner side, and measures in circumference *thirteen* inches. This tooth, it appears, is fully characterised as the fifth tooth in the lower jaw of M. giganteus.

The tooth behind this is an ultimate molar of the right side of the lower jaw. It is not removable from its socket, like the tooth last described, though not entirely fixed. Its crown is well worn though not so much as in the preceding tooth; it is divided into four ridges, has of course three transverse fissures and eight cusps, two cusps on each ridge. The cusps are all worn, the anterior ones very much, the posterior slightly. The longitudinal groove separates the cusps of the ridges from each other. There are no papillæ. The worn surface is oblong in the transverse direction, and not rounded like the Mastodon Andium, nor lozenge-shaped as in the M. longirostris. The ridge of enamel surrounding the cusps is an eighth of an inch in diameter, rather thicker than in these Mastodons usually; the cingulum is prominent on the outer edge, and flattened on the inner edge of the tooth; it measures *eighteen* inches in circumference. The anterior extremity of the tooth is as usual broader than the posterior and is partially worn away. The posterior extremity is composed by a talon with a single cusp partially fissured. This spur is about equal in size to that commonly found in this situation, but not so large as in many instances, there being behind it another tooth which checked its development.

The two teeth already described having all the characters of the fifth and sixth teeth of the Mastodon giganteus, the tooth behind the sixth is a seventh, and is the only instance of the kind I have ever seen or heard of. This tooth is situated behind the sixth, and nearly in a line with it, but projects outwards from one to two inches more than the other, while its inner face is surpassed by that of the sixth tooth three quarters of an inch. The anterior face is in contact with the posterior face of the sixth tooth to a certain extent, though not exactly; there being a slight deviation as mentioned in the position of the seventh tooth, the two surfaces in question do not correspond. The posterior face of the seventh tooth is imbedded in the bone, so that it cannot be seen, nor described; but the buried part of it seems to have the form of a talon. The external face of this tooth corresponds with the root of the coronoid process. Its superior face presents three ridges crossed by a longitudinal furrow, and separated from each other by two transverse furrows which are deep. The cusps in the exposed part are of course six in number, but although well developed, and above the tooth in front, they are very slightly worn. The principal wear is in the outer anterior cusp. This tooth, like the last described, is slightly movable in its socket: in magnitude, it is about the same as the sixth tooth, and is greater than the fifth. In construction, it resembles the sixth more than the fifth, having a fourth ridge and a well marked talon. Its cingulum is accessible on the inner and anterior faces, but not on the outer and posterior, the last being in contact with the bone. The crown may be said to be well developed, and evidently has been in use; of course the tooth may be taken out of the category of teeth imbedded in the bone, as the sixth tooth is before it is fairly cut. In another jaw, in which the fifth tooth is fully developed, those in front have disappeared, and the sixth tooth is undeveloped, but displayed by cutting away the bone so as to bring its four ridges into view.

It is obvious from what has been stated, that this tooth is a repetition of the sixth, a superadded tooth, increasing the number from six on a side to seven. It would have been fortunate, if the left side of this jaw had been preserved, but only a fragment of it remains, and this the symphysial part which does not contain any teeth, the four teeth occupying the situation in front having wholly disappeared in both sides of the jaw without leaving a trace of their sockets.

The remainder of this jaw has nothing very remarkable about it. The texture of the bone is moderately sound, and may endure for a succession of ages. The condyloid process has been broken off, and also the coronoid, but the cavity for the implantation of the temporal muscle is preserved, and the angle of the jaw is perfect. The symphysis is entire, of a wedge-like form rather than foliated, and presents no mark of the cavities for the Tetracaulodon sockets; of course it is likely to have been the jaw of a female. The front part of the symphysis measures in a perpendicular direction *five and a half* inches, and the back part *seven* inches; the latter is broader than usual, and gives more space for the lingual fossa. The orifices for the issue of the submaxillary and mental vessels are larger, the forefinger being readily admitted into the posterior opening. The canal on the left side is *one inch and three eighths* in diameter; on the left portion is a trace of an alveolus *four* inches long.

After a careful examination of the appearance of this jaw in its integral state I thought it best to uncover the extraordinary tooth, and ascertain its situation and extent. This was done not without hesitation, as it might alter the relation of the parts and bring into doubt the existence of an additional tooth. On the inner face of the bone three incisions were made, two vertical *three* inches long, and these were united inferiorly by a third horizontal incision *six* inches long. Then by cutting through the alveolar process, which passed across between the first and second fangs, the large internal plate was removed with some additional projections. When this bone was raised, we found a great molar tooth equal in size to the sixth tooth. The surface of the crown was in superficial extent full as large as that of the sixth; the anterior part rather larger than that of the other. This crown had four ridges, and a talon with a longitudinal furrow through the centre. The ridges had each two cusps, which are unworn except the two anterior; the posterior ridges, not having been fully developed, were not covered with enamel: the talon was of good size and had two or three cusps. Each of the ridges was supported as usual by a pair of fangs, the two anterior separate, the two posterior coalesced into one mass. The anterior fangs passed under the posterior fangs of the sixth tooth. The length of this tooth was *seven* inches; the width anteriorly *four* inches; the cingulum measured in circumference *sixteen and one half* inches; from the point of the fang to the tip of the corresponding second internal cusp *seven and one half* inches. From the anterior face of the anterior cusp arises an additional projection or cusp. The bone was somewhat shattered in the operation of exposing the tooth, but not sufficiently to disturb that organ, which remains in its original situation, and has never been displaced.

We naturally ask, whether this additional tooth is to be considered a *lusus naturæ*, or an instance of the power of increased dental development in old age. On page 60 of the work on the Mastodon giganteus, we have said, it is the opinion of some naturalists that the elephant may attain an age which might give him a seventh and even an eighth tooth. Mr. Corse, in his paper on this animal in the Philosophical Transactions of 1779, gives a plate representing a seventh tooth and a cavity behind it, which he thinks might have contained an eighth tooth; but Professor Owen remarks upon it, that if a tooth had existed, there would have been some remains of the calcified plates, and he does not express his belief in the existence of a seventh tooth. No instance of the kind has occurred in the Mastodon giganteus. The M. longirostris has been shown to possess in addition to the six teeth a small vertical premolar above the second and third milk molars in the upper jaw, which gives its even teeth; no such tooth has been discovered in the lower jaw as yet; and none such in the upper or lower jaw of M. giganteus.

No instance of a great supernumerary ultimate molar has been found in any species of Mastodon thus far with the present exception. Anomalies of the teeth both as to number and form are well known to exist. But the laws which govern the dentition of the Elephant and Mastodon are different from those which regulate dentition in other animals. These two pachyderms having immense teeth develop them, as we have elsewhere said, successively from behind forwards, to prevent the jaws from being overcharged with the weight at any one time. On the whole, we are disposed to consider this as the result of that law, which, in consequence of the hardness of the substances used for food, gives these animals an unusual power of dental development, which may be displayed from circumstances not known to us.

ART. XXXVI.—*Supplement to the Mineralogy of J. D. Dana,* by the Author.—Number I.

IN continuing in this Journal the semi-annual reviews of mineralogical researches, I propose to give them the form of Supplements to the last edition of my Mineralogy, believing that they will thus prove more convenient to many mineralogical readers of the Journal. The following abstracts cover the first six months since the publication of the work: they are given as briefly as is consistent with their object; and if deemed too concise, they may be taken as an index to the papers where the subjects are discussed at length. My own observations or criticisms are enclosed in brackets.

The new facts which have been brought to light, suggest no essential modification of the general arrangement of the work. Some minor changes in the grouping of the species are proposed, such as the following:—*Boltonite* according to Dr. J. Lawrence Smith, should be united to *Chrysolite:* also, as the author shows beyond, from the observations of Haidinger, *Partschin* should probably be placed near Allanite and Epidote, if not united to one or the other; *Mosandrite* also should follow Epidote; *Keilhauite*, should follow Sphene, the probability of this relation, announced by the author, having now become a certainty on crystallographic as well as chemical grounds.

Important contributions to American mineralogy have been recently made by Dr. J. Lawrence Smith, Dr. F. A. Genth, and G. J. Brush. Observations on some American minerals have also been published by Dr. Kenngott of Vienna (including analyses by M. C. von Hauer,) whose "Mineralogical Notices" are generally of great value. But owing apparently to false labels, poor specimens, or other circumstances, many of the results, although intended as corrections, serve only to multiply doubts, at least in Europe if not in this country.

I have adopted an alphabetical arrangement, and distinguished species recently proposed as new, by putting the name in large capitals.

1. *New Mineralogical Works.*

QUENSTEDT: *Handbuch der Mineralogie*, von Fr. Aug. Quenstedt, Prof. zu Tübingen. 2nd and concluding part. 1854.

KENNGOTT: 60 *Krystallformennetze* zum Anfertigen von Krystallmodellen, von Dr. Adolf Kenngott, Wien, 1854. Heft 2. A collection of figures to assist in making models of crystals—very convenient and excellent.

SCHEERER: *Paramorphismus, und seine Bedeutung in der Chemie, Mineralogie und Geologie*, von Dr. Theodor Scheerer, Prof. Köngl. Sächsischen Bergakad. zu Freiberg, 130 pp. 8vo. Braunschweig, 1854.—The work presents a review of Dr. Scheerer's latest results in Isomorphism and Paramorps.

VOLGER: Entwickelungsgeschichte der Mineralien, by G. H. Otto Volger. Zurich, 1854.

2. *Notices of Species.**

ACHTARANDITE, Breit.—Achtarandite is a pseudomorph after Helvin according to Breithaupt. Lieb. u. Kopp Jahersb., 1853, 856.

ACICULITE [p. 81].—A mineral, probably aciculite, occurs in North Carolina, at Gold Hill in Rowan Co., according to Dr. F. A. Genth, Am. J. Sci., [2], xix, 16.

ALLANITE [p, 208].—Analyses of Allanite from Orange Co. N. Y., Eckhardt's Furnace, Berks Co., Pa., and Bethlehem, Pa., by F. A. Genth, Am. J. Sci., [2], xix, 20.

Specific gravity of the Allanite of East Bradford, Pa., 3·53, and that of Bethlehem, Pa., 3·935, G. J. Brush.

ALLOPHANE [p. 336].—Analysis of allophane from Polk Co., Tenn., by Dr. C. T. Jackson, Am. J. Sci., [2], xix, 119.

ALSTONITE [p. 451].—Analysis of alstonite, by C. v. Hauer (Jahrb. Geol. Reichs., 1853, 832).

$\dot{Ba}\ddot{C}$ 65·71 $\dot{Ca}\ddot{C}$ 34·29 $\dddot{Si}$ *trace* = 100. $= \dot{Ba}\ddot{C} + \dot{Ca}\ddot{C}$

ALUM, (*Mangano-magnesian*), [p. 382].—Analysis by Dr. J. L. Smith of a specimen from the region of the Salt Lake, Utah, Rocky Mts., Amer. J. Sci., [2], xviii, 379.

ANAUXITE [p. 505].—Analyses of anauxite from Bilin, Bohemia, by von Hauer (Jahrb. geol. Reichs., 1854, 83, and J. f. pr. Ch., lxiii, 36):

$\dddot{Si}$	$\dddot{Al}$	$\dot{Fe}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{H}$ (ign.)
62·20	23·82	*trace*	1·00	*trace*	12·40 = 99·42
62·41	24·65	——	0·65	——	12·28 = 99·99

Analysis 1 gives von Hauer the oxygen ratio for the Silica, alumina and water, 8·72 : 3 : 2·974 = (nearly) 3 : 1 : 1, which is the ratio of the Cimolite of Argentiera and Alexandrowski. Probably a result of the decomposition of augite.

ANDALUSITE. [p. 257].—Analyses of Andalusite from Brazil by Damour (Ann. des Mines [5], iv, 53):

	$\dddot{Si}$	$\dddot{Al}$	$\dddot{Fe}$	$\dddot{Mn}$
I.	36·75	61·15	1·54	*tr.* = 99·44
II.	37·32	61·74	0·81	—— = 99·87
Mean,	37·03	61·45	1·17	—— = 99·65

whence the formula $\dddot{Al}^3 \dddot{Si}^2$. Specific gravity 3·160

ANTIGORITE [p. 281].—Schweizer states (Pogg. Ann., xcii, 495), that the analyses of Antigorite by him should be rejected as not accurate.

APATITE [p. 396].—A locality of apatite in trappean rocks occurs on the Achigan River, 2 miles below St. Roch, Canada, (T. S. Hunt, in Logan's Rep. Geol. Can., 1852–3, 172). The rock consists of glassy feldspar and black hornblende in small grains: the apatite is abundantly disseminated in hexagonal prisms, more or less regular.

* Kenngott's Mineral Notices, referred to beyond, are published, No. 10, in the Sitzungsber. Akad. der Wissensch., Wien, 1854, xii, 161; No. 11, ib., p. 281; No. 12, ib., p. 485; No. 13, (the last No. that has reached us,) ib., p. 701.

APHROSIDERITE, *a Chlorite-like mineral* [p. 297].—Analysis by v. Hauer (Jahrb. geol. Reichs., 1854, 79, and J. f. pr. Chem., lxiii, 30):

$\dddot{\text{Si}}$ 26·08 $\quad \dddot{\text{Al}}$ 20·27 $\quad \dot{\text{Fe}}$ 32·91 $\quad \dot{\text{Mg}}$ 10·00 $\quad \dot{\text{H}}$ 10·06 = 99·32

affording the oxygen ratio for the protoxyds, peroxyds, silica and water, 5:4·17:5·97:3·95, or quite nearly 5:4:6:4. Von Hauer appears to prefer the ratio 5:3:6:4 and deduces the formula $\dddot{\text{Al}}\,\dot{\text{H}}^4+\dot{\text{R}}^5\,\dddot{\text{Si}}^2$, and remarks on the nearness of the formula to that of chlorite (Rose), as written by Kenngott.

The aphrosiderite occurs in calcite and specular iron in minute, lustrous, crystalline laminæ, of a deep olive-green color. Rather easily decomposed by muriatic acid.

[Taking the ratio 5:4:6:4 which the analysis gives, the oxygen ratio between all the bases and the silica (excluding the water) is then 9:6 = 3:2, the same as in ripidolite (Rose), which would give the ripidolite formula $(\dot{\text{R}}^3, \dddot{\text{Al}})\,\dddot{\text{Si}}^{\frac{2}{3}}+\text{Aq}$ in which $\dot{\text{R}}^3$ and $\dddot{\text{Al}}$ are here to one another as 4:5; or including these proportions $(\frac{4}{9}\dot{\text{R}}^3+\frac{5}{9}\dddot{\text{Al}})\,\dddot{\text{Si}}^{\frac{2}{3}}+\text{Aq}$.

The ratio adopted by von Hauer, 5:3:6:4, gives for the oxygen ratio of the bases and silica 8:6 = 4:3, which is the ratio of chlorite (Rose). Thus the liberty taken with the analysis in deducing the ratios is sufficient to transfer the mineral from one of these species to the other.—D.]

ARSENOMELAN and SCLEROCLASE, *von Waltershausen.*—Description and analysis by W. S. von Waltershausen (Pogg., xciv, 123):—Occurs with the Dufrenoysite in the Binnen Valley in dolomite. Form trimetric: a brachydome of 115° 16′; angle between a plane of the brachydome and that of a macrodome 134° 59′; axes a (vertical axis) : b : c = 0·6538 : 1 : 1·0315, [giving for the fundamental vertical prism 91° 47′]. Crystals longitudinally striated. Color lead-gray to tin-white, also steel-gray to iron black. Analyses:

		S	As	Pb	Ag	Fe	
I. Lead gray;	G. = 5·393	25·910	28·556	44·564	0·424	0·448	= 99·922
II.	G. = 5·405	24·658	25·740	47·586	0·938	——	= 98·922
III.	G. = 5·469	23·949	26·458	49·657	0·629	——	= 100·693

Atomic ratio for the bases, arsenic and sulphur in I, 0·36:0·61:1·29; in II, 0·38:0·555:1·24; in III, 0·38:0·56:1·185. As the ratios do not correspond to a simple formula, von Waltershausen regards the compound as consisting of two *isomorphous* compounds, $\text{PbS}+\text{AS}^2\,\text{S}^3$ (A) and $2\text{PbS}+\text{As}^2\,\text{S}^3$ (B), and calculates that I, contains A and B in the ratio 3·124:1; II, in the ratio 1:1·234; III, in the ratio 1:0·966. He gives the name *Arsenomelan* to A, and *Scleroclase* to B. He observes that A is the formula of zinkenite, except that it contains arsenic in place of antimony, while Scleroclase (B) differs only in its arsenic from heteromorphite or feather ore. The composition of scleroclase is near that obtained by Damour in his analysis of dufrenoysite [see Min., p. 77].

[Zinkenite and Heteromophite are both regarded as trimetric; yet as far as is known, they are far from homœomorphous: for zinkenite has a prism of 120° and occurs in *hexagonal* compound crystals, while heteromorphite is not in such twins and according to von Waltershausen has nearly the form above given for arsenomelan. The hypothesis that A and B are isomorphous appears therefore to need evidence to sustain it. The angles of arsenomelan are near those of bournonite.—D.]

ATACAMITE [p. 138].—Analysis of the atacamite of Copiapo, Chili, by F. Field, (Q. J. Chem. Soc., vii, 193):

1.	Cl 14·94	Cu 56·46	$\dot{\text{H}}$ 17·79	=	CuCl 28·22	$\dot{\text{Cu}}$ 53·99	$\dot{\text{H}}$ 17·79
2.	15·01	56·24	18·00	=	28·35	53·62	18·00

whence the formula CuCl + 3CuO + 5HO. Specific gravity 4·25.

Mallet obtained in an analysis of atacamite (Ramm., 5th Suppl., 57), $\dot{\text{Cu}}$ 55·94, Cu 14·54, Cl 16·33, $\dot{\text{H}}$ 12·96, Quartz 0·08 = 99·85.

AUTOMOLITE [p. 103].—Occurs at Bridgewater, Vermont.

BALTIMORITE [p. 282].—In the Jahrbuch geol. Reichsanstalt, Wien, 1853, No. 1, p. 154, C. von Hauer published an analysis of a specimen from Texas, Pa., labelled Baltimorite, which is copied in the Mineralogy, p. 285, making it to contain 27·15 of silica, 26 of magnesia, &c. In Kenngott's Min. Notizen, No. 11, a very different result by von Hauer is published apparently from the same investigation. The specimen was a fibrous, grayish or reddish gray mineral, affording 60·53 p. c. soluble in acids, (15 p. c. of this carbonic acid, and 8·86 of water,) 39·85 p. c. insoluble in acids. From such a mixture, after a series of estimates, Baltimorite is judged to have a composition corresponding to the percentage :

$\dddot{S}i$	$\dddot{A}l$	$\dot{F}e$	$\dot{C}a$	$\dot{M}g$	$\dot{H}$
25·88	13·00	7·33	14·29	21·11	18·41

for which the formula given is $[\dot{H}^3 \dddot{A}l + \dot{R}\,\dddot{S}i] + [4(\dot{M}g\,\dot{C}a + \dot{H}) + (\dot{M}g, \dot{C}a)\,\dddot{S}i]$

[Thus we have a new analysis of a stone which somebody has labelled Baltimorite. It is very wide from the original Baltimorite of Thomson (from Bare Hills, Maryland); and is no better entitled to the name than many other fibrous stones that could be gathered from our serpentine regions. Taken as an analysis of a mineral from a serpentine region, it can hardly be esteemed of much value on account of the mixtures with it; as a correction of former accounts of the mineral Baltimorite, it is only perplexing the subject.]

BARNHARDITE [p. 500].—Dr. F. A. Genth, Am. J. Sci., xix, 17.

BARYTOCELESTINE [p. 369].—Analysis by von Waltershausen of a heavy spar containing sulphate of strontia from the dolomite of Binnen Valley in the Alps (Pogg., xciv, 134):—$\dot{B}a\,\dddot{S}$ 87·792, $\dot{S}r\,\dddot{S}$ 9·070, $\dddot{S}i$ 0·685, $\dddot{A}l$ 2·155=99·702. It occurs in nests or druses of crystals.

BAULITE [p. 248].—A specimen of this mineral consisting of an aggregation of quite small glassy crystals or grains resembling glassy feldspar in appearance, has been received by the writer from Dr. F. A. Genth. Under the suspicion that the excess of silica in the analysis might be due to mixed quartz, I examined it with a microscope, but could not satisfy myself that there was any quartz present. It appeared to be purely the baulite. The published analysis by Genth (Ann. Chem. Pharm., lxvi, 270), and Forchhammer (Skand. Nat. Samm., i, Stockholm), make the species a feldspar, in which the oxygen ratio for the protoxyds, peroxyds and silica, according to the former, is 1 : 3 : 24.—D.

BECKITE, Duf. Min., iii, 750.—A siliceous coral from Devonshire according to Kenngott, Ber. Wien Acad., x, 292.

BIOTITE [p. 225].—Analysis of the mica of Greenwood Furnace, by C. v. Hauer (Kenngott Min. Not., No. 12). Mean of results :

$\dddot{S}i$	$\dddot{A}l$	$\dddot{F}e$	$\dot{C}a$	$\dot{M}g$	$\dot{K}$	$\dot{N}a$	ign.
40·21	19·99	7·96	1·55	21·15	5·22	0·90	2·89 = 98·97

Oxygen ratio for $\dot{R}$, $\dddot{R}$, $\dddot{S}i$, 1 : 1·13 : 2·13 or 1 : 1 : 2, as in most biotites. The paper contains a review of the analyses of biotite.

[Smith and Brush obtained for the oxygen ratio from their analyses of this biotite 11·26 : 9·38 : 20·63. The sum of the oxygen of the bases equals 20·64, or just the oxygen of the silica; and the same holds true in v. Hauer's analysis, each corresponding to the general formula $(\dot{R}^3, \dddot{R})\,\dddot{S}i$.—D.] See further, *Phlogopite*.

BISMUTHINE [p. 33, 503].—Occurrence of bismuthine in Rowan Co., North Carolina, F. A. Genth, Am. J. Sci., [2], xix, 16.

BOHNERZ [p. 131].—R. Schenck (Ann. d. Ch. u. Pharm., xc, 123, and J. f. pr. Ch., lxii, 313) shows by analysis that the bohnerz of Kandern is a clayey or argillaceous limonite.

BOLTONITE [p. 167].—Boltonite, according to analyses by Dr. J. Lawrence Smith, is identical with chrysolite. He obtained (Amer. J. Sci., [2], xviii, 372,) as a mean of his results :

$\dddot{S}i$ 42·31 $\dot{M}n$ 51·16 $\dot{F}e$ 2·78 $\dddot{A}l$ 0·17 loss by heat 1·90

Analysis of boltonite by v. Hauer (Kenngott's Min. Not., No. 12):

$\dddot{S}i$ 13·32 $\dot{F}e$ 3·80 $\dot{C}a$ 29·00 $\dot{M}g$ 21·17 $\ddot{C}$ (by loss) 32·71 = 100

The boltonite was analyzed mixed with the carbonates in which it was imbedded, amounting to about ⅔ds the portion employed.

[The results of von Hauer differ widely from those of Dr. Smith, and as we have independent testimony to the general correctness of Dr. Smith's analyses, in analyses by another not yet completed, von Hauer's must be erroneous. The method adopted by von Hauer allows of too many uncertainties to be free from doubt.—D.]

Boracic Compounds [p. 392].—On the Boracic compounds of the Tuscan Lagoons, E. Bechi, Am. J. Sci., [2], xix, 119.

Brevicite [p. 327], from Clinkstone near Oberschaffhausen in Kaiserstuhl.—E. Tobler obtained in an analysis (Ann. Ch. u. Pharm., xci, 229):

$\dddot{S}i$	$\bar{\dddot{A}}l$	$\dot{C}a$	$\dot{M}g$	$\dot{N}a$	$\dot{K}$	$\dot{H}$	
43·085	29·214	12·551	0·714	3·152	0·398	11·000	= 100·114

corresponding to $\dot{R}^3\dddot{S}i^2+3\bar{\dddot{A}}l\dddot{S}i+6\dot{H}$. The oxygen ratio afforded by the analysis for $\dot{R}$, $\bar{\dddot{R}}$, $\dddot{S}i$ and $\dot{H}$ is, 1 : 3·09 : 5·18 : 2·22. Specific gravity 2·246 ; hardness = 6 ; when pulverized gelatinizes in muriatic acid.

Brongniardite.—Occurs in combinations of the regular octahedron and dodecahedron: L. Sæmann. (Communicated.)

Brucite [p. 133].—Add to the locality in the Mineralogy: occurs in Texas, Pennsylvania. The crystal figured on p. 133 was from Low's Mine in Texas and not from Hoboken.

Cacoxene [p. 424].—Analysis by von Hauer (Jahrb. geol. Reichs., 1854, 73):

$\dddot{\dddot{P}}$	$\bar{\dddot{F}}e$	$\dot{C}a$	$\dot{H}$ (loss by ignition)	Insol. in mur. acid.	
18·56	45·05	*trace*	30·94	3·63	= 98·18

Excluding the insoluble portion, von Hauer's, Steinmann's and Richardson's results are as follows:

1.	$\dddot{\dddot{P}}$ 19·63	$\bar{\dddot{F}}e$ 47·64	$\dot{H}$ 32·72,	*von Hauer.*
2.	22·28	45·32	32·38,	*Steinmann.*
3.	21·85	45·94	32·19,	*Richardson.*

giving alike the formula $\bar{\dddot{F}}e^2\dddot{\dddot{P}}+12\dot{H}$ = phosphoric acid 21·17, sesquioxyd of iron 47·07, water 31·76=100.

Calcite [p. 435, 503.]—Analyses of different limestones of the Tyrol, by A. von Hubert, Jahrb. der geol. Reichs., i, 729, and J. f. pr. Chem., lxii, 225, 1854. Also analyses of limestone and dolomite from the Saltzburg Alps, by v. Lipold, J. f. pr. Chem., lxii, 228.

A peculiar earthy calcareous rock from the tufa of Pico Crux, Madeira, afforded E. Schweizer (J. f. pr. Chem. lxiii, 201), a large proportion of silica in the soluble state. The following were the results of the analysis:

$\dddot{S}i$	$\dot{M}g$	$\dot{M}g\ddot{C}$	$\dot{C}a\ddot{C}$	$\bar{\dddot{F}}e$, $\dddot{\dddot{P}}$, etc.	Organ. subst.	$\dot{H}$	Sand	
20·38	5·39	5·15	52·12	0·36	4·76	10·00	1·57	= 99·73

The 5·39 p. c. of magnesia are regarded as in combination with silica.

The limestone of Caniçal, Madeira, which is a modern formation of calcareous sands containing shells mainly of existing species, according to the same analyst, consists of

$\dot{C}a\ddot{C}$ 84·29, $\dot{M}g\ddot{C}$ 5·48, Phosphates 1·00, nitrog. org. subst. 4·66, $\dot{H}$ 2·41, Sand 1·48=99·32

Carpholite [p. 316].—Analysis by v. Hauer (Kenngott's Min. Not., No. 12]:

$\dddot{S}i$	$\bar{\dddot{A}}l$	$\bar{\dddot{F}}e$	$\bar{\dddot{M}}n$	Ca	Fl	$\dot{H}$	
36·15	19·74	9·87	20·76	1·83	1·74	10·19	= 100·28

corresponding to $\bar{\dddot{R}}\,\dddot{S}i+1\frac{1}{2}\dot{H}$. Crystallization trimetric; in groups of acicular crystals. [The oxygen ratio 1 : 1 : $\frac{1}{2}$ is identical with that of calamine.—D.]

Chalilite [p. 326].—A massive mineral associated with chalilite (see p. 326 of Min.), looking something like bole, afforded von Hauer (Kenngott's Min. Notiz., No. 11):

$\dddot{S}i$	$\bar{\dddot{A}}l$	$\dot{F}e$	$\dot{C}a$	$\dot{M}g$	Mn	$\dot{K}$	ign.	
44·11	10·90	1·05	6·74	13·01	*trace*	*trace*	24·07	= 99·88

The oxygen ratio for the protoxyds, peroxyds, silica and water, as deduced is, 9·204 : 6·363 ; 29·211 : 26·744. Von Hauer adopts the ratio 4 : 3 : 12 : 13. [4$\frac{1}{2}$: 3 : 13$\frac{1}{2}$: 12 is much nearer the analysis, but neither this nor the other leads to any formula.]

Chiolite [p. 98].—Imperfect crystals of chiolite, from the Topaz mine of Mursinsk in the Ural, have been measured by Kenngott (Sitzungsber., xi, 980). The form, according to his observations is trimetric, with the prismatic angle 124° 22′; the acute edge of the prism is truncated, giving the angle on the prismatic faces 117° 49′. These results are wide from those of Kokscharov, who describes the form as dimetric.

Chloropal or Unghwarite [p. 504].—The analysis on p. 504 of Min. is a mean of two analyses. The result affords the oxygen ratio for the protoxyds, silica and water 1 : 6 : 3½. In the analyses of Brandes and Biewend, Kenngott supposes the iron may have been protoxyd instead of peroxyd (the latter the result of these chemists) and obtains thus the oxygen ratio 1 : 3 : 2.

Chlorophyllite [p. 215].—Measurements of a crystal of chlorophyllite are given by Kenngott (Min. Not., No. 11), and the conclusion arrived at from the angles, that it was originally iolite, a fact which the unaltered iolite often associated with it places beyond doubt.

Chrysolite [p. 184].—Observations on chrysolite by Dr. Scheerer, Handw. Chem. Lieb. Pogg., &c., 1853.

A slag from an Iron Furnace at Easton, Pa., afforded Dr. C. T. Jackson (Proc. Am. Assoc., iv, 384):

$\dddot{Si}$	$\dot{Ca}$	$\overline{\dddot{Fe}}$	$\dot{Mn}\ \overline{\dddot{Mn}}$	$\overline{\dddot{Al}}$
33·70	31·80	18·00	14·90	3·50 = 101·90

Dr. Jackson observes that the iron and manganese were probably all protoxyd, and this gives the formula $(\dot{Ca}, \dot{Fe}, \dot{Mn})^3 \dddot{Si}$. The crystals have a clove-brown color like axinite and are described as rhombohedral. [The formula is that of chrysolite. Crystals of this color and *probably* the same, from Easton, received by the writer from Dr. E. Swift, are rhombic prisms of 98° 48′, with the obtuse edge truncated and a macrodome of 132° 40′. The first angle corresponds to the prism $1\breve{\imath}$ in chrysolite which equals 99° 6′, and the last approaches $i\bar{2}$, which equals 130° 2′.—D.]

Chrysotil [p. 282].—Analysis of chrysotil from serpentine at Abbottsville, N. J., by E. L. Reakirt, under the direction of Dr. Genth, Amer. J. Sci., [2], xviii, 410.

Clinochlore [p. 293].—M. N. de Kokscharov has measured anew the chlorite (ripidolite, von Kobell) of Achmatowsk, and come to the conclusion that the form is monoclinic, and that the species is identical with clinochlore which last name he adopts for it. No optical characters are given. Akad. Wiss. St. Petersburg, 1854, and Am. J. Sci., [2], xix, 176.

Clintonite [p. 297, 505].—Analyses by Plattner (Breith. Min., ii, 385) of a specimen from Amity:

$\dddot{Si}$	$\overline{\dddot{Al}}$	$\overline{\dddot{Fe}}$	$\dot{Mg}$	$\dot{Ca}$	$\dot{H}$
21·4	46·7	4·3	9·8	12·5	3·5 = 98·2

The zirconia in the analysis, p. 505 of Min. was due to zircon mechanically mixed.

Copiapite [p. 387].—Dr. J. L. Smith obtained in his analyses the formula $\overline{\dddot{Fe}}\,\dddot{S}^2 + 11\dot{H}$. G. = 1·84. Amer. J. Sci., [2], xviii, 375.

Couzeranite [p. 206].—In part altered scapolite according to Kenngott, Sitzungsber. xii, 714. One specimen examined was different, but composition not ascertained; form a square or perhaps rhombic prism. H. = 6·5. G. = 2·85.

Cuban [p. 68].—Analysis by Dr. J. Lawrence Smith, agreeing with Prof. Booth's, Am. J. Sci., [2], xviii, 381.

Danburite [p. 212].—Specific gravity by a new determination, 2·958, G. J. Brush.

Datholite [p. 334].—The crystalline form of the datholite of Andreasberg has been studied by R. Hess (Pogg. Ann., xciii, 380). He obtained for the inclination of O on $i\breve{\imath}$ 89° 56·2′ in one crystal, and 89° 59·2′ in another; and from these and his other measurements concludes that the axis is vertical, or at least within 1 minute of 90°. He obtained for $I : I$ (see Min. for lettering, and this Jour., xvii, 215) 115° 15·2′; for $i\breve{2} : i\breve{2} = 76° 42′$; $2\breve{\imath} : 2\breve{\imath}$ (over O) = 115° 25′. [The datholite of Roaring Brook afforded the writer for $I : I$, 115° 12′.—D.]

Analysis of crystals from the Gabro Rosso, Mt. Caporciano, Tuscany, by Bechi, (Am. J. Sci., [2], xiv, 65):

$\dddot{Si}$ 37·500 $\overline{\dddot{Al}}$ 0·852 $\dot{Ca}$ 35·341 $\dot{Mg}$ 2·121 $\dddot{B}$ 22·033 $\dot{H}$ 1·562 = 99·413

whence Bechi deduces the formula $2(\dot{Ca}^3\,\dddot{Si}^4 + 3\dot{Ca}\,\dddot{B}) + \dot{Mg}\,\dot{H}^2$ = $\dddot{Si}$ 38·75, $\dddot{B}$ 21·93, $\dot{Ca}$ 35·36, $\dot{Mg}$ 2·09, $\dot{H}$ 1·87. The small proportion of water is a remarkable peculiarity of this variety. [The ratio between the oxygen of the silica and all the other ingredients in this formula is 24 : 33, and in the analysis 24 : 34, or very nearly 2 : 3, which is probably the true ratio, affording the general formula $(\dot{R}^3, \dot{H}^3, \dddot{B})\,\dddot{Si}^{\frac{3}{2}}$].

DELVAUXITE [p. 427].—Analysis by von Hauer (Jahrb. k. k. geol. Reichs., 1854, 68, and J. f. pr. Ch. lxiii, 13), taking the percentage after excluding the silica:

$\overline{\ddot{P}}$	$\overline{\ddot{Fe}}$	$\dot{Ca}$	$\dot{H}$
20·93	52·03	7·94	19·08 = 99·98
20·04	52·54	8·37	19·04 = 99·99

Von Hauer thence deduces the formula $\dot{Ca}^2 \overline{\ddot{P}} + \overline{\ddot{Fe}}^5 \overline{\ddot{P}} + 16\dot{H}$.

DIAMOND [p. 24].—A large diamond of pure water, from the Province of Minas Geraes, Brazil, has been described by Dufrenoy. It is a dodecahedron with bevelled edges, and weighs 254½ carats. It is called the "Star of the South." There are impressions of diamond crystals in it, showing that it is one of a cluster that were formed together probably in a geode like quartz crystals. L'Institut, No. 1096, and Am. J. Sci., [2], xix, 288.

DIASPORE [p. 128].—The locality of diaspore at the Topaz vein, Trumbull, Conn., mentioned on page 483 of Min., may be added at page 129.

DOLOMITE [p. 441].—Analysis and description of the dolomite of the Binnen Valley, in the Alps, containing the Dufrenoysite, &c., by W. S. v. Waltershausen (Pogg., xcii, 115): Structure saccharoidal; G. = 2·845. Composition, $\ddot{C}$ 45·566, $\dot{Ca}$ 29·852, $\dot{Mg}$ 20·488, insoluble 3·314 = 99·220, or very nearly 1 of $\dot{Ca}\ddot{C}$ to 1 of $\dot{Mg}\ddot{C}$. Besides Dufrenoysite, the dolomite contains blende, pyrites, orpiment, realgar, arsenomelan, etc.

DUFRENOYSITE [p. 77].—Analysis of Dufrenoysite by W. S. v. Waltershausen (Pogg., xciv, 120):

S	As	Ag	Pb	Cu	Fe
27·546	30·059	1·229	2·749	37·746	0·824 = 100·153

affording von Waltershausen the formula, the iron being supposed to be in the condition of mixed pyrites, $[R^2 S + As^2 S^2] + R S$ in which R is mainly copper.

Von Waltershausen says that in Damour's analysis the mineral used must have been mixed with arsenomelan (q. v.). He was careful to analyse the monometric crystals. G. = 4·477, mean of 3 determinations.

EDINGTONITE [p. 323].—Analysis by M. F. Heddle (Phil. Mag., [4], ix, 179), $\dddot{Si}$ 36·98, $\overline{\dddot{Al}}$ 22·63, $\dot{Ba}$ 26·84, $\dot{Ca}$ and $\dot{Na}$ *trace*, $\dot{H}$ 12·46 = 98·91. G. = 2·694. The analysis, p. 323, is the deduced percentage corresponding to the formula.—*Glottalite* of Thomson is regarded by Mr. Heddle as impure Edingtonite.

EHLITE [p. 426].—According to Kenngott (Sitzungsber, xii, 26), the Ehlite from Ehl near Linz on the Rhine, is similar in form to liroconite, being trimetric; the summit is a dome, or two planes meeting in an edge.

EUKOLITE [p. 343].—Trimetric, with an angle of 120° nearly, having 3 cleavages, meeting at an angle of 60°; and a fourth at right angles with the three; optically biaxial according to Damour: L. Sæmann. (Communicated.)

EUXENITE [p. 358].—Description and analysis by David Forbes (Edinb. N. Phil. J., [2], i, 62). Mineral from Alve on Tromoen, an island near Arendal, Norway. Apparently trimetric; observed planes ∞, ∞-$\bar{\infty}$, ∞-$\breve{\infty}$, m-$\bar{\infty}$, 1. Approximate measurements by M. Dahl: $\infty : \infty\text{-}\breve{\infty} = 117°$, $\infty : \infty = 126°$, $\infty\text{-}\bar{\infty} : m\text{-}\bar{\infty} = 154° 30'$, $\infty\text{-}\breve{\infty} : 1 = 107°$. Cleavage none. H. = 6·5; G. = 4·99 at 60° F. of a small crystal; of a pure fragment of a crystal 4·89. Lustre brilliant and metallic vitreous; in very thin splinters translucent with a reddish brown color. Fracture conchoidal.

In a glass tube no change of color or lustre, B.B.; alone, infusible and unchanged; with borax in the oxydating flame, gives a brownish-yellow glass, somewhat lighter in color when cold; in the reducing flame unchanged, even on flaming; with salt of phosphorus, a glass greenish-yellow while hot, nearly colorless on cooling. No action of titanium or manganese although containing both of these metals. Composition:

	$\ddot{Cb}$	$\ddot{Ti}$	$\overline{\dddot{Al}}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{Y}$	$\dot{Ce}$	$\dot{Fe}$	$\overline{\dddot{U}}$	$\dot{H}$
	38·58	14·36	3·12	1·27	0·19	29·36	3·31	1·98	5·22	2·88 = 100·37
Oxygen	4·53	5·79	1·45	0·38	0·07	5·87	0·47	0·43	0·61	2·56

Some columbic acid is mixed with the titanic acid. The oxygen in the columbic acid (Rose's niobic) is deduced from the atomic weight of tantalum. The ratio for the acids and bases, excluding the water is 10·32 : 9·28.

[If the titanic acid be reckoned with the bases (see Min.) the ratio is 4·53 : 15·07, which, allowing for some columbic acid with the titanic acid, may point to the ratio 1 : 3 ; this would give the formula $\dot{R}\ddot{C}b$ or $(\dddot{R}, \dot{R}^3)\ddot{C}b^3$, which is analogous to the formula of tantalite. There is some approximation to the form of tantalite, the occurring prism being 126° in euxenite, and 122° 54′ in tantalite; or, taking another view of their relative positions, the angle 117° above may correspond to $O : \frac{3}{2}\breve{\imath}$ in tantalite which is 117° 2′. But without further crystallographic examinations it would be premature to assert a near relation.—D.]

FELDSPARS [p. 228].—A review of the various analyses of different species of the feldspar and scapolite families of minerals is given by Scheerer in the Handwörterbuch d. Chemie, Braunschw., 1853, and an abstract, in Neues Jahrb., 1854, 593.

FELSOBANYITE [p. 134].—Felsobanyite of Haidinger has been referred to gibbsite. Haidinger sustains it as a good species in the Sitzungsber., xii, 183. giving the following characters. Usually in concretions; also in 6-sided folia, with two angles of 112°. Crystallization trimetric, optically biaxial. H. =1·5 ; G. =2·33 (Kenngott). Cleavage-face pearly. Color snow-white, surface often yellowish. Composition according to C. v. Hauer, $\dddot{A}l^2\,\dddot{S} + 10\dot{H}$ = sulphuric acid 17·18, alumina 44·15, water 38·66. Analysis afforded:

$\dddot{S}$ 16·47 $\dddot{A}l$ 45·53 $\dot{H}$ 37·27 = 99·27

The mineral is hence near websterite, and particularly paraluminite, [p. 509].

FICINITE.—*Ficinite* of Bernhardi, by some referred to Vivianite, has been examined by Kenngott (Min. Not., No. 11), and is described as follows: it is from Bodenmais in Bavaria, where it occurs with garnet, iolite, etc. Form monoclinic; cleavage perfect in one direction, and also in a second inclined 129° to the former, both parallel to the orthodiagonal. Color black; within greenish-brown. Lustre weak; waxy or pearly. Subtranslucent. H. =5.0–5·5 ; G. =3·4–3·53. In a glass tube yields water, without much change. B.B. fuses to a semimetallic slag, which is magnetic; with borax and salt of phosphorus a clear bead colored by iron which becomes opaque and whitish on cooling. In acids hardly attacked. Ficinus obtained in his analysis:

$\dddot{P}$	$\dddot{S}$	$\dot{F}e$	$\dot{M}n$	$\dot{C}a$	$\dddot{S}i$	$\dot{H}$
12·82	4·07	58·85	6·82	0·17	0·17	16·87

Kenngott remarks that it is probably not vivianite, but more nearly related to the triphyline group.

FLUOLITE.—A mineral of this name from Iceland, mentioned in Glocker's Mineralogy, is a pitchstone, according to Kenngott (Min. Not., No. 12). H. =6·5 ; G. =2·24. Greenish black in the mass and vitreo-resinous. Composition according to v. Hauer:

$\dddot{S}i$	$\dddot{A}l$	$\dddot{F}e$	$\dot{M}n$	$\dot{C}a$	$\dot{M}g$	$\dot{K}$	$\dot{N}a$	$\dot{H}$ (ign.)
67·470	13·375	1·785	*trace*	3·025	*tr*	1·380	2·870	9·500 = 99·405

The oxygen ratio afforded for $\dot{R}$, $\dddot{R}$, $\dddot{S}i$, $\dot{H}$ is 2·1 : 6 : 34·4 : 8·1.

FRANKLINITE [p. 106].—The following important note is by Mr. George J. Brush, having been received by letter dated Freiberg, Jan. 27, 1855.

Note on Abich's analysis of Franklinite.—In consulting Abich's monograph on the Spinel group,* the writer has observed some errors in the calculations of the analysis of Franklinite† which it may be well to note. In this analysis, Abich obtained 68·88 $\dddot{F}e$, which, considering the iron to exist in the mineral as magnetite ($\dot{F}e\,\dddot{F}e$), he erroneously makes equivalent to 47·52 $\dddot{F}e$ and 21·34 $\dot{F}e$, the correct numbers being 45·93 $\dddot{F}e$ and 20·67 $\dot{F}e$.

Again, 1·094 grm. $\dot{M}n\dddot{S}$ he calculated as equal to 0·440 grm. $\dot{M}n$; it should be 0·515 grm. which on 2·690 grm. mineral used for analysis gives 19·14 $\dot{M}n$, or 21·29 $\dddot{M}n$, instead of 16·44 $\dot{M}n$ or 18·17 $\dddot{M}n$, the amount stated by Abich. The analysis corrected reads:

$\dddot{F}e$	$\dot{F}e$	$\dddot{M}n$	$\dot{Z}n$	$\dddot{A}l$	$\dddot{S}i$	$\dot{M}g$ and $\dot{C}d$
45·93	20·67	21·29	10·81	0·74	0·40	*traces* = 99·84.

($\dddot{F}e$ and $\dot{F}e$ together:) $\dddot{F}e$ 68·88

* Pogg. Ann., xxiii, 305.

† *Ibid.*, p. 345. The errors do not appear to be typographical.

GARNET [p. 190].—Black garnet or melanite occurs with feldspar at Warren, Chester Co., Pa. The aplome of Keim's mine, Pa., is rather a brown garnet than true aplome.

Analysis of the fine red garnet from Yonkers, N. Y., sometimes called pyrope, and also of another similar from Green's Creek, Delaware Co., Pa., by F. A. Genth, Am. J. Sci., [2], xix, 20.

GALACTITE.—Description by Kenngott (Min. Not., No. 11). A zeolitic mineral in needles, which have cleavage parallel to a rhombic prism, near 91° in angle (v. Zepharovich). Color partly reddish white. Lustre of fracture vitreous, H. =4·5–5; G. =2·21. In a tube yields water, and becomes opaque white. B.B. intumesces and fuses easily to a clear colorless glass, and shows a siliceous skeleton on cooling. Gelatinizes readily in heated muriatic acid. Mean of analyses by C. v. Hauer:

	$\ddot{Si}$	$\dddot{Al}$	$\dot{Ca}$	$\dot{K}$	$\dot{Na}$	$\dot{H}$ at ign.	$\dot{H}$ at 100° C.
	46·99	26·84	4·36	0·45	9·68	10·56	0·49 = 99·37
[Oxygen,	24·89	12·53	1·24	0·07	2·50	9·38	

The oxygen ratio for the protoxyds, peroxyds, silica and water, as deduced by v. Hauer, is 0·305 : 1 : 2·629 : 0·784, for which von Hauer writes 2 : 6 : 15 : 5, and deduces the formula $2(\dot{Na}, \dot{Ca})\ \dddot{Al} + 5\dot{H}\ \ddot{Si}$. From the Kilpatrick Hills, and Dunbarton, Scotland. [Recalculating the oxygen ratio as given in the second line in the analysis, we obtain 3·81 : 12·53 : 24·89 : 9·38, or nearly (supposing a small deficiency in the protoxyds) 1 : 3 : 6 : 2, the ratio of natrolite; whence galactite is probably *Natrolite.*—D.]

GEOCRONITE [p. 85].—Probably occurs at Tinder's Gold mine, Louisa Co., Va., according to Dr. F. A. Genth, Am. J. Sci., [2], xix, 19.

GIESECKITE [p. 233].—Analyses of gieseckite, from Greenland, by von Hauer (Jahrb. geol. Reichs., 1854, 76, and J. f. pr. Chem., lxviii, 27), with also the analyses of Stromeyer (Gott. gel. Anz., iii, 1993, 1819), and Pfaff (Schw. Jahrb., xlv, 103):

	$\ddot{Si}$	$\dddot{Al}$	$\dddot{Fe}$	$\dot{Fe}$	$\dot{Mn}$	$\dot{Mg}$	$\dot{K}$	$\dot{H}$	
1. Kangerdluarsak,	46·40	26·60	—	6·30	*trace*	8·35	4·84	6·76 = 99·36,	*v. Hauer.*
2. "	45·36	27·27				7·39		6·87	*v. Hauer.*
3. Akulliarasiarsuk,	46·08	33·83	3·36	—	$\dddot{M}$ 1·16	1·20	6·20	4·89 = 96·71,	*Strom.*
4. "	48·0	32·5	4·0	—	——	1·5	6·5	5·5 = 98·0,	*Pfaff.*

Von Hauer deduces the ratio for the silica, alumina, protoxyds, and water, 4 : 2 : 1 : 1 (or exactly 4 : 2·05 : 0·92 : 1·00, which affords him the formula $\dot{R}^3\ \ddot{Si} + \dddot{Al}^2\ \ddot{Si}^3 + 3\dot{H}$) differing considerably from the other analyses. Stromeyer observes that his material may not have been quite pure from the feldspar with which it was mixed. Haidinger, Tamnau, Blum and Kenngott have taken the ground that gieseckite is altered elæolite or nepheline. The mineral analyzed by von Hauer became brownish red after heating; and it was partly soluble in muriatic acid.

GOLD [p. 7].—At Beresofski, gold is sometimes interlaced with crystallized galena. (Communicated by G. J. Brush.)

GYROLITE [p. 305].—According to L. Sæmann, a specimen of gyrolite examined by him was mixed or interlaminated with another, presenting all the characters of pectolite; and he suggests that pectolite, on losing its alkali, takes a lamellar texture and becomes gyrolite; and losing its lime becomes okenite. (Communicated.)

HARRINGTONITE [p. 328].—Analysis of Harringtonite by C. von Hauer (Kenngott's Min. Notiz., No. xi):

$\ddot{Si}$	$\dddot{Al}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{Na}$	$\dot{H}$ at ign.	$\dot{H}$ at 100° C.
45·07	26·21	11·32	*trace* (?)	3·75	12·93	1·41 = 100·69

whence the oxygen ratio for $\dot{R}$, $\dddot{R}$, $\ddot{Si}$ and $\dot{H}$ is 1 : 3 : 6 : 3, and the composition is observed to be that of mesolite.

HAARCIALITE.—This name in Dufrenoy's Mineralogy, arose from a mis-reading of a label of Haarzeolith: L. Sæmann. (Communicated.)

HELVIN [p. 194].—An analysis of helvin by Rammelsberg (Pogg. Ann., xciii, 455, afforded the following results, to which Gmelin's is subjoined:

S 5·71	$\ddot{Si}$ 33·13	$\dddot{Be}$ 11·46	$\dot{Mn}$ 49·12	$\dot{Fe}$ 4·00 = 103·42,	*Ramm.*
5·06	33·26	12·03	40·45	5·56 ign. 1·15 = 97·51,	*Gm.*

Supposing the 5·71 of sulphur combined with manganese (of which it requires 9·77 p. c., and makes 15·48 sulphuret of manganese), the analysis becomes, according to Rammelsberg:

Mn S 15·48 $\dddot{\text{Si}}$ 33·13 $\ddot{\bar{\text{Be}}}$ 11·46 $\dot{\text{Mn}}$ 36·50 $\dot{\text{Fe}}$ 4·00 = 100·57

giving the formula, Mn S + [($\dot{\text{Mn}}$, $\dot{\text{Fe}}$)^3 $\dddot{\text{Si}}$ + $\ddot{\bar{\text{Be}}}$ $\dddot{\text{Si}}$], and not according with the garnet formula.

[Although this does not precisely sustain the writer's formula given in his Mineralogy, a comparison of the percentage corresponding to his formula with the above may be of some interest; the percentage is as follows:

Mn S 14·6 $\dddot{\text{Si}}$ 34·1 $\ddot{\text{Be}}$ 9·6 $\dot{\text{Mn}}$ + $\dot{\text{Fe}}$ 41·7 = 100.—D.]

Helvin has been obtained at Brevig, Norway, in a zeolitic gangue: L. Sæmann. (Communicated.)

HETEROMERITE [p. 199.]—In the Jahrb. k. k. geol. Reichsanstalt for 1853, at p. 155, C. v. Hauer published an analysis of heteromerite from Slatoust as given in the Min., p. 169. In Kenngott's Min. Notizen, No. 10, Kenngott publishes a different result by v. Hauer as follows:

$\dddot{\text{Si}}$	$\ddot{\bar{\text{Al}}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{Fe}}$	ign.
36·59	22·25	34·81	*trace*	4·56	0·55 = 98·76,

This analysis gives the oxygen ratio for the protoxyds, peroxyds and silica, 3½ : 3 : 6, which if taken at 3 : 3 : 6=1 : 1 : 2 is the ratio of idocrase, to which species Kenngott refers it, as had been done before the analysis in 1853.

Kenngott in this paper reviews the analyses of idocrase, comparing the proportion of the protoxyds and peroxyds, but not, what is of more importance, the oxygen ratio of all the bases and silica.

HORNBLENDE [p. 170].—*Nordenskiöldite* according to Kenngott (Min. Not., No. 12) is a variety of tremolite occurring mixed with calcite. An analysis by v. Hauer of a specimen containing 38·27 p. c. of carbonates, is given.

HUDSONITE [p. 160].—Kenngott observes (Min. Notizen, No. 11) that the Hudsonite has a cleavage parallel to a prism of 124°, like hornblende, and is near hedenbergite, in composition.

[On reëxamining this mineral, which is like sahlite in structure, we find, besides the basal planes of lamination, an orthodiagonal cleavage distinctly inclined about 106° to the base, and also another varying much in angle, but in general making an angle with the diagonal of about 135°; the last appears to correspond to the lateral faces of the prism of pyroxene. No cleavage parallel to a prism of 124° is apparent on our specimens.

The oxygen ratio deduced by Kenngott from his recalculations of the analysis of Brewer, is the same given by the writer, that is 14·91 : 30·42 = 1 : 2 for the oxygen of the protoxyds and $\dddot{\text{Si}}$ + $\ddot{\bar{\text{Al}}}$.

The recent analysis of Smith and Brush,

	$\dddot{\text{Si}}$	$\ddot{\bar{\text{Al}}}$	$\dot{\text{Fe}}$	$\dot{\text{Mn}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{K}}$	$\dot{\text{Na}}$	ign.
	38·94	10·42	30·49	0·60	10·35	3·00	2·48	1·66	1·95
Oxygen,	20·63	4·87	6·70	0·13	2·96	1·21	0·41	0·43	

gives for the oxygen ratio for the protoxyds and silica ($\ddot{\bar{\text{Al}}}$ included) 11·84 : 25·50, which is intermediate between the hornblende and augite ratios, the former requiring 11·84 : 26·64, the latter 11·84 : 23·68. The mineral analyzed, we have reason to know, had every appearance of purity.—D.]

HYALOPHAN, *von Waltershausen.*—Description and analysis by von Waltershausen (Pogg., xciv, 134). Form monoclinic and resembling orthoclase; $I : ii$ (see figure 421 of orthoclase, Min., p. 242) =120° 36, $O : 1i$ =130° 55½′, $1i : I$=111° 55′. By calculation, C (or inclination of vertical axis) = 64° 16′ 8″. Color white. H. =6·5; G. =2·711–2·832. Crystals single, or in groups of two or three. Analysis (mean result):

$\dddot{\text{Si}}$	$\ddot{\bar{\text{Al}}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{Na}}$	$\dot{\text{Ba}}$	$\dddot{\text{S}}$	$\dot{\text{H}}$
24·127	49·929	1·570	0·420	5·742	14·403	2·702	0·650 = 99·543

giving the formula 3$\dot{\text{R}}^2$ $\dddot{\text{Si}}$ + 5$\ddot{\bar{\text{Al}}}^3$ $\dddot{\text{Si}}$ + $\dot{\text{Ba}}$ $\dddot{\text{S}}$ = Silica 24·03, alumina 50·52, lime 1·57, magnesia 0·42, soda 5·75, barytes 15·08, sulphuric acid 2·63. Occurs with barytocelestine in the dolomite of the Binnen Valley.

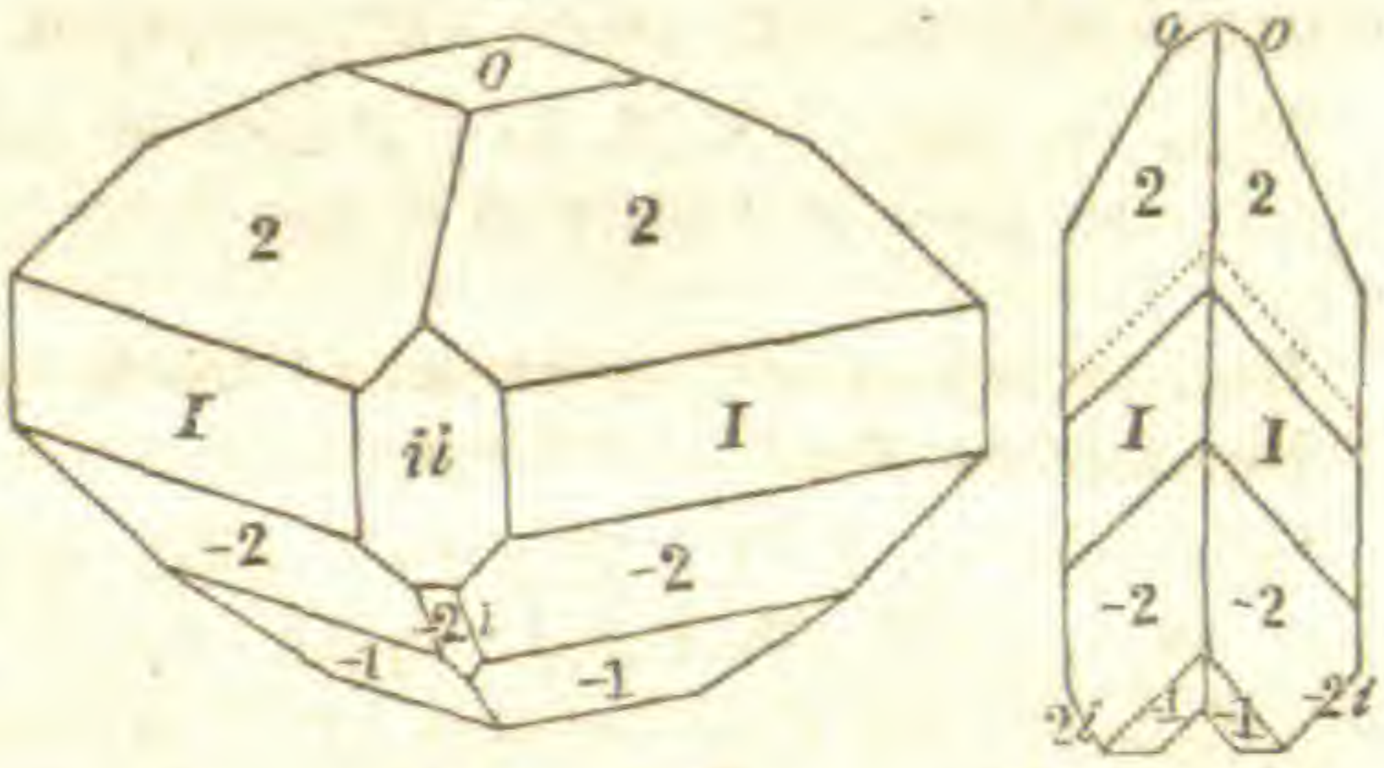
[In this formula, the first member has the oxygen ratio 2 : 3, the second 9 : 3, a very wide diversity. Considering the oxygen ratio of the bases and silica, we observe that this ratio, according to the above, is 24·67 : 12, or nearly 2 : 1, which is the ratio in staurotide, as if the compound might possibly come under the general formula $(\dot{R}^3, \ddot{R})\,\dddot{Si}^{\frac{1}{2}}$. It is remarkable that the crystalline form should be almost identical with that of orthoclase, suggesting the idea of a pseudomorph,—against which view however, the hardness of the mineral and its bright faces seem to stand opposed.]

Iodyrite or Iodic Silver [p. 95, 506].—Analysis of the Chilian iodyrite by Damour (Ann. d. Mines, [5], iv, 329): Iodine 54·03, silver 45·72=99·75, (mean of two analyses) corresponding to Ag I^2. Specific gravity 5·707 at 8° C. Becomes deep orange at 300° C. but resumes its yellow color on cooling.

Iridosmine [p. 19].—Claus found palladium in the iridosmine of the Urals.

Keilhauite [p. 341].—Description by D. Forbes (Edinb. N. Ph. J., [2], i, 62). Monoclinic, according to crystals obtained by Mr. Dahl at Arkeroen, Norway. [See angles below]. Some of the crystals weighed 2½ lbs.; the faces were rough and the angles were measured only by the common goniometer. The crystals were generally twins (fig. 2). G. =5·53 at 60° F. Analysis:

1. 2.



	$\dddot{Si}$	$\ddot{Ti}$	$\ddot{Al}$	$\ddot{Be}$	$\dot{Ca}$	$\dot{Y}$	$\dot{Fe}$	$\dot{Mn}$
	31·33	28·84	8·03	0·52	19·56	4·78	6·87	0·28 =99·41
Oxygen,	15·06	11·18	3·75	0·32	5·56	0·95	1·52	0·06

The analysis agrees nearly with those of Erdmann and Scheerer. Taking the $\ddot{Ti}$ as base, the oxygen ratio of the silica and bases is then 2 : 3, and the formula, Dr. Forbes observes, may be $(\dot{R}^3, \ddot{R})\,\dddot{Si}^{\frac{2}{3}}$, which is the same as that of sphene.

[These results afford a complete confirmation of the writer's conclusion respecting the basic relation of the titanic acid in sphene, and also of his published view of Keilhauite. As the above formula for sphene has not been written as above except by the writer recently in this Journal, xviii, 130, and his Mineralogy, Dr. Forbes obviously adopts the view, and agrees with the writer in objecting to the so-called silico-titanates and silico-tantalates. The resemblance in formula between keilhauite and sphene is mentioned in this Journal and in the writer's Mineralogy. This important paper adds the confirmation required by showing that the *form* is monoclinic like sphene: and more than this, what the paper does not recognise, that the angles are closely like those of sphene. The accompanying figure 1 is drawn from the data afforded by the figures; the lettering is like that of sphene in the places referred to. The corresponding lettering of Dr. Forbes and of Brooke and Miller is here given:

O	2	*I*	–2	–1	*ii*	–2*i*	*Dana.*
a	–*o*	T	+*o*	*s*	M	*n*	*Forbes.*
y	*n*	*r*	*t*	*l*	*c*		*B. & M.*

The following are the angles measured by Dr. Forbes; and in a separate column the corresponding angles of sphene are given from Brooke and Miller:

Keilhauite.		Sphene, B. and M.	
I: *ii* =147°	- - - -	(*r* : *c*)	146° 44′
–2 : –1 = 149°	- - - -	(*t* : *l*)	150° 17′
–*ii* : 2*i* = 125°	- - - -	(*c* : *v*)	126° 26′
O : *ii* =122°	- - - -	(*y* : *c*)	119° 33′
2 : *I* = 153° 30′	- - - -	(*n* : *r*)	152° 45′
2 : *O* =143° 30′	- - - -	(*n* : *y*)	141° 36′

From calculations made by Mr. Hansteen, *O* : *I* is given as 114° 25′ 43″; it is 114° 21′ in sphene; *O* : -1 is given at 140° 42′, while it is 139° 20 in sphene. Considering the roughness of the faces, the approximation is close. The form of the crystal is very near the variety lederite of Shepard. See the writer's Min., ii,

268. The twins resemble those of sphene, being compounded parallel to the plane *ii*. These results therefore confirm entirely the announcement by the writer that keilhauite and sphene are related.—J. D. D.]

Lanthanite [p. 456].—J. Lawrence Smith, Amer. J. Sci., [2], xviii, 378.

Leuchtenbergite [p. 294].—Observations on the crystallization of leuchtenbergite by Kenngott, Min. Not., No. 12.

Matlockite [p. 127].—Angles according to Kenngott (Min. Not., No. 11), 1 : 1 (basal edge) = 121° 2′; 2*i* : 2*i* (basal edge) = 136° 17′.

Melinite of unknown locality. Melinite is a hydrous silicate of alumina. Analysis by v. Hauer (Jahrb. Geol. Reichs., 1853, 828):

$\ddot{\text{Si}}$	$\ddot{\bar{\text{Al}}}$ (by loss)	$\ddot{\bar{\text{Fe}}}$	$\dot{\text{Ca}}$	$\dot{\text{H}}$
46·54	26·79	14·92	0·39	11·36 (of which 1·08 lost at 100° C.) = 100
46·47	40·82		——	11·64 " 1·06 " "

Corresponds to 10·27 silica, 7·08 peroxyds, and 11·42 water.

Mica [p. 225].—M. N. de Kokscharov announces that according to his measurements the mica of Vesuvius is not hexagonal but trimetric with the habit monoclinic.

Note on the optical character of mica, by Grailich, Sitzungsber., Wien, xii, 536. See further, *Biotite*, *Phlogopite*.

Mimetene [p. 401].—Mimetene and a *vanadate* of lead occur at the Wheatley Mine, near Phœnixville, Pa.: J. L. Smith, Am. J. Sci., [2], xix, 127.—Analysis of mimetene of Caldbeck Fell, Cumberland, by C. Rammelsberg, (Pogg., xci, 316):

$\ddot{\bar{\text{As}}}$	$\ddot{\bar{\text{P}}}$	$\dot{\text{Pb}}$	$\dot{\text{Ca}}$	Pb	Cl
18·47	3·34	68·89	0·50	7·04	2·41 = 100·64

corresponding to $3\dot{\text{Pb}}^3$ ($\ddot{\bar{\text{As}}}$, $\ddot{\bar{\text{P}}}$) + Pb Cl. G. = 7·218. In muriatic acid soluble with difficulty, but perfectly.

Mispickel (Arsenikkies) p. [62, 509].—Analysis by *Freitag*, Rammelsberg's Handw. 5th Suppl. 55; by *C. v. Hauer*, Jahrb. k. k. geol. Reichs., iv, 400; *Ragsky*, ib., 828. See also Lieb. u. Kopp Jahresb., 1853, 779.

Molybdate of Iron.—The occurrence of a mineral containing molybdic acid and sesquioxyd of iron, in Heard Co., Georgia, which is probably a molybdate of iron, is announced by Mr. W. J. Taylor. It is in deep yellow silken tufts, formed of delicate fibres or acicular crystals coating quartz, and resembles the California molybdate described by D. D. Owen.

Molybdenite [p. 66].—Molybdenite occurs in Canada in a vein of quartz intersecting white crystalline limestones north of Balsam Lake, on a small island in Big Mud Turtle Lake. It is associated with greenish scapolite, green cleavable pyroxene and iron pyrites (Logan's Rep. Geol. Canada, 1852–3, 144).

Mosandrite [p. 342].—L. Sæmann states in a recent communication to the writer that he has fine specimens of mosandrite in prisms, having the aspect of epidote, thus confirming the suggestions on p. 343 of Min.

Nitre or Nitrate of Potash [p. 433].—Nitre, according to Frankenheim is dimorphous, like carbonate of lime, one form (the common one) prismatic like aragonite, the other rhombohedral like calcite. Both may exist between the temperatures − 10° C. and 300° C. The prismatic (α) is normal between these temperatures; the rhombohedral (β) abnormal, and easily transformed into the prismatic by different influences such as the presence of some foreign substances, or of a crystal of the prismatic kind. At a higher temperature near the fusing temperature of nitre, the rhombohedral is normal and the prismatic abnormal, the latter changing to the former, and retaking again its form as the temperatnre diminishes.—Pogg. Ann., 1854, xcii, 354.

Oligoclase [p. 239].—Analysis of oligoclase from Zrnin near Krumau in Bohemia, where it occurs in granulite, by v. Hauer (Jahrb. geol. Reichs., 1853, iv, 830):

$\ddot{\text{Si}}$ 63·16 $\ddot{\bar{\text{Al}}}$ 23·16 $\dot{\text{Ca}}$ 3·00 $\dot{\text{K}}$ 0·17 $\dot{\text{Na}}$ 9·72 $\dot{\text{H}}$ 0·79 = 100

Scheerer presents views in a paper in the Handwört. Chem. of Liebig, Poggendorff, &c., on the composition of oligoclase, and the existence of compounds intermediate between it and orthoclase and albite, one of which he calls oligoclase-albite and the other oligoclase-orthoclase.

ORPIMENT [p. 32.]—Kenngott (Sitzungsber, xi, 982) opposes the view of G. H. O. Volger, that orpiment is in general a result of the alteration of realgar.

OZOCERITE [p. 474].—P. G. Hofstädter in Ann. Ch. u. Pharm., xci, 326, on natural and artificial paraffin.

PALÆO-NATROLITE.—Scheerer, Pogg. Ann., xciii, 95.

PALAGONITE [p. 166].—Observations on palagonite, by Scheerer, Handw. Chem. Lieb., Pogg., &c., 1853.

PARTSCHIN [p. 501].—Description of partschin from Ohlapian, by W. Haidinger (Sitzungsb., xii, 480):—Monoclinic; $C=127° 44'$. Fundamental prism (∞)=91° 52′, a clinodiagonal prism of 116°. The planes without lustre, and measurements only approximations. Cleavage indistinct.

H.=6·5–7. G.=4·006, C. v. Hauer. Lustre weak greasy. Slightly subtranslucent. Composition according to C. v. Hauer:

	$\ddot{S}i$	$\dddot{A}l$	$\dot{F}e$	$\dot{M}n$	$\dot{C}a$	$\dot{H}$
1.	35·28	19·03	14·38	29·11	1·82	0·38 = 100
2.	34·89	18·95	13·86	29·34	loss 2·77	

whence, as v. Hauer observes, it has the garnet oxygen ratio, 1 : 1 : 2, and garnet formula. Haidinger remarks upon the mineral as dimorphous with garnet, and especially with the variety spessartine.

[The oxygen ratio of partschin is the same with that of allanite, which species too, is dimorphous with garnet. Moreover the form also is near that of allanite; and hence it is in all probability a closely related mineral. The angle 127° 44′ corresponds to $O : 1i = 128° 45'$ in allanite: the prism 91° 52′ is the clinodome $\frac{4}{3}i$, which would be 93° 42′ in allanite. The discrepancies in angle are not so large as they appear, when it is noted that the faces are rough.—D.]

PHLOGOPITE [p. 224].—Kenngott endeavors to show in his Min. Not., No. 13, (1) that the mineral called phlogopite by Shepard and Dana is not Breithaupt's phlogopite; and (2) that it is not optically biaxial. On the *first* point he remarks that the description does not agree with Breithaupt's description; *ergo* it cannot be the mineral he described. On the *second*, he states that in his observations with a polariscope, the appearances are the same as for the *biotite* of Greenwood Furnace, and hence the ellipses observed are only distorted circles.

[These are both errors. The specimen of phlogopite on which Breithaupt instituted the species *was sent him by Prof. Shepard*, and Prof. Shepard received soon after a letter mentioning that he had so named it.* Hence Prof. Shepard was not ignorant of the mineral or its locality, nor were other American mineralogists to whom American micas and localities are familiar. When Prof. Shepard stated the angle at 120° to 121° 15, while Breithaupt said 121° 15′, it was because he had found 120° the angle from his many specimens; while irregularities allowed of the

* NOTE BY PROF. SILLIMAN, JR.—As M. Kenngott has suggested a doubt as to the correctness of our recognition of the mica called phlogopite by Breithaupt—inasmuch as he asserts that the characters of the micas described in Shepard's and Dana's works on Mineralogy by that name do not correspond with those given by Breithaupt to the mica from Antwerp, N. Y.,—it is well for me to state in the absence of Prof. Shepard, that our first knowledge in America of Breithaupt's species phlogopite was from a letter written by the Saxon Mineralogist to Prof. Shepard, and which I had the pleasure of reading. In that letter he first applies this name to a reddish yellow somewhat brownish mica from Antwerp, Jefferson Co., N. Y., associated with calcite and serpentine, a specimen of which Prof. Shepard had sent to him not long before. A portion of this same specimen I saw in Prof. Shepard's hands at the time alluded to, and from its entire similarity to other known specimens of the locality and those I have since measured (from one of which the figure beyond has been made) there cannot be the smallest doubt of our correctness. I may add, that all the micas from that portion of Northern New York, which I have seen and examined with reference to their optical characters, belong to the species *phlogopite* with angles from 7° to 17°; or to biotite, and not to muscovite.

variation to 121° 15′. In fact no mica affords normally for the vertical prism (if not oblique) any other angle but 120° and its supplement 60°; this is the angle of the basal cleavage section in all cases. It is useless to consider other characters mentioned by Breithaupt; for Kenngott would have made no such argument if he had been aware of the facts.

The error as to the optical characters arose from the examination of too thin a plate.

3. 4.

The annexed figures by the writer from a thick plate (¼th of an inch) render words unnecessary. They are from an Antwerp (Natural Bridge) mica, the same in locality with that sent Breithaupt;* and moreover are very similar to the phlogopites of Edwards, Pope's Mills, and other localities, as the writer has especially observed. The figures are made from views just now shown the writer by Prof. Silliman, Jr. The angle between the apparent optical axes has just been measured by Prof. Silliman, and found to be 15° to 15½°. The results of the measurements of different phlogopites are given in the writer's Mineralogy, p. 219.

Whether biotite is a distinct species is another question. The chemical composition of phlogopite, as far as known, is different, the oyygen ratio for $\dot{R}$, $\ddot{\bar{R}}$, $\dddot{Si}$, being 3 : 2 : 5, or perhaps 7 : 4 : 11, while in biotite it is 1 : 1 : 2. But both of these ratios appear to occur in idocrase, while the latter is characteristic of garnet. There is here a subject for further investigation.

It is unnecessary to follow Kenngott in his review of the analyses.—D.]

PICRANALCIME [p. 318].—The crystals of picranalcime, a specimen of which the writer has received from E. Bechi, are as clear and glassy as any analcime and show no evidence of alteration.—D.

PITCHSTONE [p. 248].—The pitchstone of St. Natolia, Sardinia, afforded Delesse Bull. Soc. Geol. de France, xi, 105):

$\dddot{Si}$	$\ddot{\bar{Al}}$	$\dot{Fe}$	$\dot{Mn}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{K}$	$\dot{Na}$	H and organic
62·59	16·59	3·17	0·55	1·16	2·26	6·48	3·14	3·90 = 99·83.

Resembles a black pitch and is associated with trachyte.

A review of analyses of pitchstone is given by Scheerer, Handw. Chem. Lieb., Pogg., &c., 1854. See also *Fluolite.*

PITKARANDITE.—"A paramorphic amphibole species," Scheerer, Pogg. Ann., xciii, 100. Habit that of augite. Color leek-green, light or dark. From Pitkaranda in Finland. Composition according to R. Richter:

	$\dddot{Si}$	$\ddot{\bar{Al}}$	$\dot{Fe}$	$\dot{Mn}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{H}$
	61·25	0·41	12·71	0·83	9·17	13·30	2·52 = 100·19
Oxygen,	31·80	0·19	2·82	0·18	2·62	5·32	2·24

whence Scheerer deduces the oxygen ratio for the silica and protoxyds, 31·93 : 11·69 = 11 : 4. [Excluding the water the ratio is 31·80 : 10·94 = nearly 12 : 4 = 3 : 1 or taking for the atomic weight of silica 566·25, which is most generally adopted, it becomes 32·45 : 10·94, which is very closely 3 : 1, the ratio of some steatite.—D.]

PLATINA [p. 12].—The name platina is not a diminutive of *Plata, silver,* but signifies *silver-like:* E. Uricochoea of Bogota, Inaug. Dissert.

* Both the Vrooman's Lake and Natural Bridge localities are in Antwerp, and the micas are of similar character, differing a little only in the optical angle. Breithaupt's specimen came from Natural Bridge.—D.

Plumbocalcite [p. 438].—Von Hauer obtained in an analysis of plumbocalcite from Leadhills, Scotland, 92·43 carbonate of lime and 7·74 carbonate of lead = 100·17. G. = 2·772; H. = 3·0. White to pale reddish-white. Kenngott's Min. Not., No. 13.

Polyhalite [p. 377].—H. Rose states (Pogg. Ann., xciii, 1) that according to an examination of the mineral from Vic in Lorraine (that analyzed by Berthier) by Mr. Dexter, the gray variety as well as the red consists of polyhalite, mixed with a hydrous silicate of magnesia and alumina. An analysis of the polyhalite of Hallein by Behnke, and of that of Aussee by Mr. Dexter, afforded:

	$\dot{Ca}\dddot{S}$	$\dot{Mg}\dddot{S}$	$\dot{K}\dddot{S}$	$\dot{Na}\dddot{S}$	Na Cl	$\dddot{Si}$	$\dot{H}$	
1.	42·29	18·27	27·09	2·60	1·38	0·27	6·10	= 98·00, B.
2.	45·62	18·97	28·39	0·61	0·31	0·32	6·02	$\dot{Mg}$ 0·49, $\dddot{\bar{F}}e$ 0·24 = 100·97, D.

Analysis 1, contains also 1·35 p. c. of basic sulphate of sesquoxyd of iron.

Prosopite [p. 502].—Scheerer in Poggendorff's Annalen, xcii, 612, has made some additions to his observations on prosopite, but without any complete analysis. A somewhat similar mineral from Schlackenwald is described.

Pyrophyllite [p. 303].—Analysis by Dr. F. A. Genth, of pyrophyllite from Crowder's Mtn., N. Carolina, in Am. J. Sci., [2], xviii, 410. The analyses lead to the formula $\ddot{\bar{A}}l^2 \dddot{S}i^5 + 2\dot{H}$.

Pyrites [p. 54].—Specific gravity of 52 crystals, according to von Zepharovich, between 3·769 and 5·185, the lowest, of crystals partially altered to limonite: polished crystals 4·8–5·185. Kenngott's Min. Not., No. 11.

PYRORETIN, *Reuss.*—Pyroretin is a new fossil resin from the Brown Coal formation near Aussig in Bohemia, described by A. E. Reuss (Sitzungsb., xii, 551). It occurs in plates sometimes an inch thick and in nodules; is brittle; brownish-black; greasy resinous in lustre; hardness of gypsum; streak-powder dull wood-brown. Burns easily with a reddish yellow flame and a smell like burning amber, leaving a black coaly residue. Heated, it blackens and melts easily, and begins to intumesce from incipient decomposition, and on cooling forms a black asphaltum-like mass. Begins to melt at 100° C., and if kept at this temperature gives off oxygen. Analysis by J. Staněk:

Carbon 80·02 Hydrogen 9·42 Oxygen 10·56

corresponding to the formula $C_{40} H_{28} O_4$. It is near the Beta resin of the Pinus Abies according to Johnson, which gave $C_{40} H_{29} O_5$, differing only by 1 atom of water. Dissolves in hot alcohol, and is deposited again on cooling.

Pyroxene [p. 158].—Analysis of augite from Sasbach, by E. Tobler, (Ann. Ch. u. Pharm., xci, 230):

	$\dddot{Si}$	$\ddot{\bar{A}}l$	$\dot{\bar{F}}e$	$\dot{Mn}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{Na}$	$\dot{K}$	$\dot{H}$	
	44·40	7·83	11·81	0·11	22·60	10·15	2·13	0·65	1·03	= 100·72
Oxygen,	23·52	3·65	2·62	0·02	6·46	3·92	0·55	0·11	0·91	

If the alumina replaces silica, the formula is that of augite, the oxygen ratio being 13·68 : 27·37 = 1 : 2.

Other new analyses, Lieb. u. Kopp. Jahrsb., 1853, 797.

Kenngott has observed the prism $\infty - \frac{3}{2}$ in a diopside from Schwarzenstein in the Tyrol. (Min. Not., No. 13.) This mineralogist has reviewed in the same paper the analyses of pyroxene with reference to the alumina.

Pyroxenic Rocks.—A paper on the original composition of some pyroxene rocks, by E. Söchting, is published in the Halle Zeitschr. für die gesammten Naturwissenschaften, Sept., 1854, iv, 194.

Pyrrhotine [p. 50].—The magnetic pyrites of meteoric irons is found by Dr. J. Lawrence Smith to be a protosulphuret of iron, corresponding to the formula Fe S (instead of $Fe^7 S^8$) = Sulphur 36·36, iron 63·64. Analysis afforded Sulphur 35·67, iron 62·38, nickel 0·32, copper *trace*, silica 0·56, lime 0·08 = 98·91. G. = 4·75. Am. J. Sci., [2], xviii, 380.

Retinite, see *Pitchstone.*

Ripidolite, see *Clinochlore.*

Saline efflorescence *from the Desert of Atacama.*—F. Field, Quart. J. Chem. Soc., vii, 308. A few miles to the east of the port of Caldeca in the north of Chili, the soil for many leagues around is white with a saline efflorescence looking like a recent fall of snow. An analysis afforded:

$\dddot{S}$ 42·60 Cl 19·63 $\dot{N}a$ 27·17 $\dot{C}a$ 6·72 $\dot{M}g$ 4·75 $\dot{H}$ 12·30

with traces of oxyd of iron and carbonates of lime and soda; which corresponds to the following, part of the sodium being united to the chlorine:

$\dot{N}a\dddot{S}$ 41·77 $\dot{C}a\dddot{S}$ 16·32 $\dot{M}g\dddot{S}$ 13·75 Na Cl 15·60 $\dot{H}$ 12·30 = 99·74

It is perfectly soluble in cold water, if added in sufficient quantities and digested with it for a long time. Soluble in dilute hydrochloric acid with scarcely perceptible effervescence. Slightly alkaline to test paper, owing probably to a trace of carbonate of soda. Dissolved in water at 100° F. and allowed to cool, it deposits large crystals of sulphate of soda. One pound of the soil produces more than its own weight of crystallized sulphate of soda.

Scapolite [p. 201].—Analysis of a scapolite from near Perth, Canada, by T. S. Hunt (Logan's Rep. Geol. Surv. Canada, 1852–53, p. 168) found in a boulder; H. =5·5; G. =2·640–2·667; color greenish-gray; subtranslucent:

$\dddot{S}i$	$\dddot{A}l$	$\dot{F}e$	$\dot{C}a$	$\dot{M}g$	$\dot{K}$	$\dot{N}a$	ign.
46·30	26·20	0·60	12·88	3·63	2·88	4·30	2·80 = 99·59

It differs from ordinary scapolite in the large proportion of potash and also the magnesia present.

Scorodite [p. 419, 511].—Occurrence in Cabarras Co., N. C., F. A. Genth, Am. J. Sci., [2], xix, 23.

Scolecite [p. 328]—.Analysis of scolecite from the E. Indies, by W. I. Taylor in the laboratory of Dr. F. A. Genth, Am. J. Sci., [2], xviii, 410.

Seladonite (Terre Verte).—The analysis, p. 511 of Min. is pnblished also in the Ann. d. Mines, [5], iv, 351.

Serpentine [p. 282, 511]—The crystals of serpentine from Easton, Pa., were examined and pronounced pseudomorphs after hornblende and augite by G. Rose (Pogg., lxxxii, 511). The angles of the augite form given by Rose, agree closely with those of augite; one only gave a discrepancy, that of $O : ii$, which was 1° 48′ less. Hermann has since measured the hornblendic form (Pogg., xcii, 287), and finds considerable divergence from unaltered hornblende. He obtained −1 : −1 = 143° 67′ (instead of 148° 30′), and $O : ii$ = 112° 4′ (instead of 104° 50′). He regards both these hornblendic and augitic forms, as *new species of serpentine* and not pseudomorphs.

[The writer has received a hornblendic serpentine crystal from Dr. E. Swift of Easton, which gives for −1 : −1, 148° 15′–148° 30′, using the reflecting goniometer (with the reflection of the light of a candle); and approximately 104½–105° for the edge −1 : −1 on *ii* (an uneven rounded plane) with the common goniometer; (it is 106° in hornblende). The variations from the hornblende angles are therefore evidently irregularities, and there is no sufficient reason for regarding the crystals as other than pseudomorphs. Dr. Swift observes that there are unaltered crystals of augite and hornblende of similar form in the same vicinity.—D.]

Severite [p. 504].—Analysis of severite from St. Sévère, in France, by C. v. Hauer (Jahrb. geol. Reichs., 1853, 826):

$\dddot{S}i$ 44·42 $\dddot{A}l$ 36·00 $\dot{C}a$ 0·65 $\dot{H}$ 18·40, (of which 2·95 lost at 100° C.) = 99·47

Corresponds to 9·8 parts of silica, 7 alumina and 17·17 water. Amorphous and earthy, with a white color.

Silver Glance.—The ore of Prince's Location, Lake Superior, is chiefly native silver in thin laminæ in calcite with quartz, silver glance, copper glance, blende and erythrite; some assays of the crude ore afforded T. S. Hunt 3·5 p. c. of silver containing a little gold. (Logan's Report Geol. Surv. Canada). Horn silver is said to have been found there.

Smithsonite [p. 447].—Herrerite of Del Rio has been shown by Dr. F. A. Genth to be a cupriferous Smithsonite. (Proc. Acad. Nat. Sci. Philad., vii, 232).

SPHERULITE and RETINITE or PITCHSTONE [p. 248].—Analysis by Delesse (Ann. d. Mines [5], 457):

	Si	Al	Fe	Mn	Mg	Ca	K	Na	ign.	
1. Spherulite,	72·20	15·65	1·64	0·50	0·62	0·98	1·71	5·52	1·12=99·49	G.=2·459
2. Retinite,	70·59	13·49	1·60	0·30	0·70	1·31	4·29	3·52	3·70=99·50,	G.=28·36

Spherulite includes concretions, often somewhat radiated, in pitchstone. The two analyses here given are from the same mass. The formation of spherulite within the retinite is regarded as an impure crystallization of feldspar.

SPODUMENE [p. 169].—Specific gravity of variety from Sterling, 3·182: J. L. Smith.

SULPHUR [p. 22].—A brownish sulphur of Radoboy in Hungary, owes its color according to Magnus (Pogg. Ann., lxii, 657) to mixture with a bituminous substance impregnating a little earthy material, the whole amount of this material being about 0·2 per cent.

SYLVANITE [p. 64].—Kenngott has compared (Sitzungsber. Akad. Wien, xi, 977) all the analyses of sylvanite and shown that the ratio between the tellurium (including the antimony) and the other metals varies between 2·48 : 1 and 3·66 : 1, the mean being about 3 : 1.

TETRADYMITE [p. 21, 512].—Analyses by Dr. F. A. Genth of tetradymite from Fluvanna Co., Va., Am. J. Sci., [2], xix, 16. The results correspond closely with the formula Bi Te^3 = Tellurium 48·06, bismuth 51·94.

TETRAHEDRITE (Gray Copper, or Fahlerz) [p. 82, 512.]—Analysis of the mineral from Eldridge's Gold Mine, Va., and Cabarras Co., N. C., F. A. Genth, Am. J. Sci., [2], xix, 18.

THURINGITE [p. 290].—Owenite identical with Thuringite, Dr. F. A. Genth, Amer. J. Sci., [2], xviii, 411.

TUNGSTATES.—Wolfram, Scheelite and probably *Tungstate of Copper*, [Min., p. 502], in North Carolina, F. A. Genth, Am. J. Sci., [2], xix, 22.

TYRITE, D. Forbes.—Resembles euxenite. Occurs in crystals having a square section, but too irregular and unreflecting for measurement. Cleavage none. H. =6·5; G. =5·30 at 60° F. 5·56 of a massive piece. Color and lustre same as in euxenite.

Heated in a glass tube decrepitates strongly, evolves water, and the powder resulting from the decrepitation is of a brilliant yellow color. B.B. with borax forms a glass of a reddish yellow color when warm, but colorless on cooling; with salt of phosphorus, soluble with difficulty, the glass greenish yellow while hot, green when cold. Analysis:

	Cb	Al	Ca	Y	Ce	U	Fe	H
	44·90	5·66	0·81	29·72	5·35	3·03	6·20	4·52 = 100·25
Oxygen,		2·64	0·23		0·77	0·35	1·38	4·02

Taking the atomic weight of tantalum for that of columbium, the oxygen ratio of bases and silica is 5·23 to 11·31, [which is that of Columbite]. Occurs with euxenite at a place called Hampemyr, Norway.

WARWICKITE [p. 395].—Analysis of warwickite by T. S. Hunt,* (Amer. J. Sci., [2], xi, 352):

Ti 31·5 Mg 43·5 Fe 8·1 Loss on ignition 2·0 = 85·1

This analysis was made on the small lustrous unchanged crystals. G. =2·89. The loss in the analysis, which for want of material was not investigated, is explained by the recent discovery of boracic acid by Dr. J. Lawrence Smith.

Specific gravity, according to G. J. Brush, of fresh small crystals of warwickite, 3·351; of large crystals, 3·423. (Communicated.)

On p. 231, Min., vol. i, the proportion of boracic acid in warwickite should be stated at 15 to 20 per cent.

* Mr. Hunt's Enceladite was instituted as a species on the large crystals of the warwickite, which had undergone, as he suggests, partial alteration. The composition obtained differed totally from Prof. Shepard's results (as have all other examinations), and appeared at the time to indicate that the mineral was a distinct species.

WITTICHITE (Kupferwismutherz), [p. 88].—Analyses 1, 2, by R. Schneider (Pogg. Ann., xciii, 305 and 472),—and 3, R. Schenck (Ann. Ch. u. Pharm., xci, 232):

Sulphur,	16·15	15·87	16·64
Bismuth,	51·83	50·62	52·51
Copper,	31·31 = 99·29	33·19 = 99·68	30·85=100

Schneider deduces the formula $2\text{Cu}\,S + Bi\,S^2$, Bi standing for the double atom of bismuth; or $[3\text{Cu}\,S + Bi\,S^3] + x\,Bi$, supposing it to contain some metallic bismuth. Schenck gives the formula $2\text{Cu}\,S + Bi\,S^3$ = Sulphur 19·28, bismuth 50·14, copper 30·58. In his analysis, he obtained 2·54 of iron which he excludes as mixed sulphuret of iron.

WOLFRAM [p. 351].—Analysis of a wolfram from Neuhaus Stollberg near Stassburg, by R. Schneider (Pogg., xciii, 474):

$\dddot{W}$ 76·57 $\dot{F}e$ 18·98 $\dot{M}n$ 4·90 $\dot{C}a$ 0·70 $\ddot{M}n$ *trace* = 100·95

The protoxyd of iron and manganese are to one another as 4 : 1.

XENOTIME [p. 401].—The xenotime of Georgia contains, according to Dr. J. Lawrence Smith (Am. J. Sci., [2], xviii, 378), Phosphoric acid 32·45, yttria 54·13, oxyd of cerium with a little lanthanum and didymium 11·03, oxyd of iron 2·06, silica 0·89 = 100·56 = $(\dot{Y}, \dot{C}e)^3 \dddot{P}$.

Errata and Addenda to Mineralogy.—VOLUME I.—P. 67, l. 14th fr. top, after 1, *add*, "the plane a regular hexagon."—p. 197, after l. 9, *add*, Xenotime, $O:1=138°30'$. —To p. 238, list of papers on slags, *add*, *Rammelsberg* in Pogg., lxiv, 95, and Lehrbuch der Chem. Metallurgie;—*Hausmann*, Beit. zur Kenntniss der Eisenhohofen Schlachen nebst einem geologischen Anhange, from Studien des Gött. Ver. Bergm. Freunde, and an abstract in Am. J. Sci., [2], xviii, 422.—*J. D. Dana's* criticisms on Hausmann's paper, Am. J. Sci., ibid.;—*C. T. Jackson*, analysis of a slag from Easton, Pa., Proc. Amer. Assoc., iv, 384 (also this Suppl., under CHRYSOLITE).

VOLUME II.—P. 8, anal. 1, for Linarowski, *read* Syranowski.—p. 32, l. 10 and 11 fr. top, for $i\breve{}$ and $2\breve{}$, *read* $i\breve{2}$, $2\breve{2}$; also in part of edition, for 2, *read* $\breve{2}\breve{2}$.—p. 40, top l., for Jargionite, *read* Targionite; and the corresponding change should be made in the Index.—p. 44, 5 l. from top, before rock, *read* serpentine.—p. 47, over column of analyses, *add*, S, Cu, Fe.—p. 102, 28 l. fr. top, for specular iron, *read* magnetite.—p. 117, 9 l. fr. top, *trf.* G. =4·56–4·66 to line above after Syenite; and in 8 l. fr. top, after Bay, *dele* and.—p. 130, 6th analysis, for Breithaupt, *read* Brandes; and 7th analysis, for Breithaupt, *read* Plattner, and after $\ddot{S}i$, *add*, and loss—p. 138, l. 12 fr. bottom, *add* $\dot{C}u$ and $\dot{H}$ before 2nd and 3d columns of analysis.—p. 171, in f. 359, 360, for $1i$, *read* -1, and for $O, -1i$.—p. 181, 22 l. fr. top, for $\ddot{F}e$, *read* $\dot{F}e$.—p. 189, 19 l. fr. top, transpose 72·85 and 27·15.—p. 190, 6 l. fr. top, for 25·14, *read* 55·14.—p. 204, in analysis 10, the 6·68 is water.—p. 210, 12 l. fr. bottom, *dele* "at St. Paul's, Canada West."—232, l. 18 fr. bottom, for $\frac{4}{3}$, *read* $\frac{3}{2}$.—p. 256 and 257, in formula of Gehlenite, for each $\frac{3}{4}$ and $\frac{1}{4}$, *read* $\frac{1}{3}$.—p. 269, l. 14 fr. bottom, put the semicolon of l. 15th after Island; and in l. 15, for Yemaska, *read* Yamaska.—p. 274, 17 l. fr. bottom, insert after C. W., "with idocrase and garnet" from the next line.—p. 279, before analyses of Crocidolite, *add* Analyses by Stromeyer (Pogg., xxiii, 153).—p. 284, in analysis 26, *add* $\dot{N}a$ 0·90, and in last l., for Westchester, Chester Co., *read* Texas, Lancaster Co.—285 anal. 1 of Metaxite, for $\dot{F}e$, *read* $\ddot{F}e$.—p. 318, anal. 1, for 35·12, *read* 55·12.—p. 360, 21 l. fr. top, for Nischne Tagilsk, *read* Beresofski; and where Beresof occurs, it should be Beresofski.—p. 389, l. 24 from bottom, for $\dot{F}e$, *read* $\ddot{F}e$.—392, 5 l. from bottom, for Danburite, *read* Datholite.—p. 395, l. 19 from top, for $\dot{F}e$ *read* $\ddot{F}e$.—457, 2 l. from top, for Waltershausen, *read* Wachtmeister.—p. 503, l. 20 fr. bottom, for Kenngott, *read* Kokscharov.—p. 505, l. 17 fr. top, for G. A. Brush, *read* G. J. Brush.—Add, aknowledgments to R. P. Greg, Jr., for figures of crystals of Leadhillite, Susannite, Linarite, Triphyline. The author would mention again his obligations to Mr. Greg for various important facts respecting British mineralogy, and also for many communications relating to European minerals and localities, which were most generously contributed.

P. 497, in Canada localities, for Aubert, *read* Aubert-Gallion: after Boucherville *add* Mountain: for Polton *read* Potton; after St. Norbert, for Amethyst, *read* Apatite; after WALLACE MINE, *add* Arsenical and Sulphuret of Nickel, and Nickel Vitriol; after BRUCE'S MINES, another locality, *add* Copper glance, Erubescite: *add* PRINCE'S LOCATION, on Lake Huron (see above, SILVER GLANCE). The author is indebted for the list of Canada localities to Logan's Rep. Geol. Canada, and to Mr. T. S. Hunt.

P. 498.—*On the Geological Ages of the Crystalline Limestones;* (Communicated). —The crystalline limestones of northern New York, and those of the whole of the north side of the St. Lawrence Valley are by Mr. T. S. Hunt referred to the Laurentian [Azoic] System of rocks, which underlies the New York system, while the marbles of western Vermont, of Berkshire Co., Mass., of northwestern and southwestern Connecticut, and of southern New York, N. Jersey and Pennsylvania belong to the Trenton group of Lower Silurian rocks. The serpentines and dolomites which are found all along the eastern line of these limestones from Lower Canada through Vermont and Massachusetts, to Winchester and Litchfield, Conn., and which are again seen at New Haven, Milford and Hoboken, appear to belong to the upper part of the Hudson River group; while the limestones extending from Lake Memphremagog, down the Connecticut River Valley, to Halifax, Vt., and thence through Coleraine, Ashfield, Deerfield, Whately and Bernardstown in Mass., are Upper Silurian; to which also belong the calcareo-micaceous rocks of western Connecticut, and probably those of Bolton farther east in the same State. The limestones of eastern Massachusetts, as in Chelmsford, Bolton and Boxborough, and those of Walpole and Attleborough, he supposes to be of Devonian and Carboniferous age. The same crystalline minerals occur alike in the highly altered rocks of the Laurentian, Lower Silurian and Devonian systems. See Mr. Hunt's paper in the Am. Jour. Sci., [2], xviii, 193.

ART. XXXVII.—*Review of Murchison's Siluria.**

THE geologist whose field of observation has been within the limits of the United States where the formations are spread out on so grand a scale and where there are such immense gaps in the series, can hardly look at the geological map of England without wondering at the perfection of the sequence in that country and the smallness of the space into which so great a variety of formations have been crowded. Hardly a link in the chain, as recognised by European geologists, can be said to be wanting: of the 28 *ètages*, or groups, into which all the fossiliferous rocks have been divided by d'Orbigny, only two have not been recognised in England, and of these, one, the ètage Danien, is only a few yards in thickness. And how much of the ardor and success with which geology has been cultivated in England is due to the multiplicity and variety of the facts forcing themselves, as it were, into the notice of every one who ever cast a glance at the rocks beneath his feet. The facilities which that country affords for obtaining a clear insight into the structure of the earth gives to the English geologist, in some important respects, very great advantages over his co-laborers in the same science in this country. Not to speak of the physical suffering which must be gone through in exploring the remote portions of our territory, how

* SILURIA: *The History of the Oldest known Rocks containing Organic Remains, with a brief sketch of the Distribution of Gold over the earth;* by Sir RODERICK IMPEY MURCHISON, &c. &c. London, 1854.

much we lose in the rapidity and accuracy of our observations for want of good geographical maps. European geologists have as a basis for their operations almost an exact miniature copy of the surface, on which every elevation, every undulation of the ground, every land-mark, every stream and almost every house is laid down. With such maps he is not obliged to be his own surveyor, topographer and draughtsman, and he is never at a loss to know where he is in the world. Another great advantage which an old and thickly inhabited country possesses over a new one, is the aid afforded by artificial sections of the rocks, such as are furnished by canal and railway cuttings, deep wells, mines or quarries. When the structure of a country is complicated, such helps become of the greatest importance, and the geologist who is deprived of their aid is often obliged to leave the most interesting problems unsolved. Great Britain, small as is the space she occupies on the map of the world, is the first of nations in mineral and metallic wealth, and depends more exclusively for her national prosperity on that branch of her industry with which geology is most intimately connected, than any other country. Thus it is that this science has at all times been a favorite there, and its cultivators have been numerous, devoted and highly successful.

In the course of the development of English geology those rocks naturally got the first attention which were most accessible, most thickly filled with organic remains, and most simple in their stratigraphical position. The remoter districts of Wales and the north of England were comparatively neglected, under the idea that the rocks of those regions were too scantily supplied with fossils and too much metamorphosed ever to be reduced to a system of consecutive groups. The same was the case on the continent. The German geologists had contented themselves with calling all the rocks below the Old Red Sandstone primary and transition; but the line of division between them was rarely attempted to be drawn. Grauwacke was one of those indefinite names under which were ranged a great variety of rocks of different ages. Some attempts were made, it is true, to separate the transition rocks in Germany into groups; but as these classifications were based on mineralogical and not on palæontological grounds, they were of no value in any general application; they implied no real progress in the task of unravelling the order of succession of the older rocks. The first step in the right direction seems to have been taken by Hisinger, who showed, in 1826, that the older fossiliferous rocks of Sweden might be separated into two groups, according to the nature of their fossil contents. In this country we were quite as completely in the dark on the subject of our older geological formations as they were in Europe in regard to their own. In the words of Murchison, "Before the labors which terminated in the publication of the 'Silurian System,' no one had unravelled the detailed sequence and characteristic fossils of any strata of a higher antiquity than the Old Red Sandstone; and even that formation was only known to be the natural base of the carboniferous or mountain limestone, and to contain a few undescribed fossil fishes. Not only were the relations and contents of the inferior strata undefined, but even many rocks which are now known to be younger than the Silurian, were then considered to be of much more remote antiquity. No one had then surmised that the great series of hard slates with limestones and fossils, which have been termed Devonian, is an equivalent of the Old Red Sandstone, and younger than, as well as distinct from, the deposits of the still older Silurian era. On the contrary, British authorities believed (and I was myself so taught) that the schistose and subcrystalline rocks of Devonshire and Cornwall were about the most ancient of the vast undigested heaps of greywacke. In short, the best geologists of my early days were accustomed to leave off with such rocks, as constituting obscure heaps of sediment, in and below which no succession of 'strata as identified by their fossils' could be detected.'"

It was in 1831 that Murchison, desirous of throwing some light on this dark subject, under the advice of Dr. Buckland, began his explorations along the borders of England and Wales, where the older rocks are well developed. At the same time Prof. Sedgwick, with similar intentions, selected North Wales as the field of his labors, and for many years both these gentlemen labored indefatigably to elucidate the order of succession of the palæozoic strata. In 1833 and 1834, Murchison presented various papers containing the results of his observations to the Geological Society of London, and in the last named year prepared a classification of these ancient strata, which is essentially the same as the one now sustained by him, the rocks below the Old Red being grouped into four formations (Ludlow rocks, Wenlock and Dudley rocks, Horderly and May Hill rocks, afterwards named Caradoc, and Builth and Llandeilo flags) the whole underlaid by the unfossiliferous greywacke of the Longmynd. In 1835 the name Silurian was given to these four groups, and the distinction between upper and lower Silurian was established. Eight years of persevering labor were at length worthily crowned by the appearance of the magnificently illustrated quarto, entitled, "The Silurian System," which appeared in 1838. In this work, so well known to every geologist, the fossils which up to that time have been discovered in the Silurian groups were described and figured by the most eminent English palæontologists, and thus the means were placed in the hands of geologists throughout the world of studying their older formations and comparing them with those of England. Nothing could have been more opportune for American geologists than the promulgation of the Silurian System. The study of our fossiliferous rocks had just been seriously commenced in this country by the organization of the geological surveys of the great states of New York and Pennsylvania, which are chiefly occupied by the strata of the same age as those studied by Murchison, but developed on a vastly greater scale and in a much completer sequence. At this time the greatest confusion prevailed in regard to the position, age and nomenclature of our palæozoic strata. The Silurian and Devonian rocks of Pennsylvania were simply designated as "secondary" by the State Geologist in his first report (1836). In the same year Mr. Featherstonhaugh described all the rocks of the Northwest, including the whole series from Lower Silurian up to the coal, as being of carboniferous age, and in his report for the previous year he had made still greater confusion in attempting to classify the rocks of the Atlantic States. Troost had also considered the Silurian of Tennessee as carboniferous, and Eaton had identified rocks of the same age in New York as of the age of the New Red Sandstone.

Great was the impetus given to palæozoic geology by the establishment of the Silurian System, and geologists everywhere began to search among their transition and greywacke rocks for the equivalents of the group, established by Murchison. No one however was more active in extending his system to foreign countries than our author himself, and with the especial object of finding fresh confirmation of the truth of the British palæozoic classification he visited Russia, and with the aid of de Verneuil and under the especial patronage of the Emperor, carried out, in the years 1840 and 1841, an extensive survey of Russia in Europe and the Ural mountains. In 1842, '3 and '4, farther investigations were made by Count von Keyserling in Russia and by Murchison himself in England, Germany and Scandinavia, and in 1845 the results of these laborious and costly researches appeared in the form of two quarto volumes entitled "The Geology of Russia in Europe and the Ural Mountains," a work printed and illustrated in a style of truly imperial magnificence. Besides this work and the "Silurian System," numerous papers by Murchison, either alone or associated with Sedgwick or Verneuil, appeared in the transactions and proceedings of the Geological Society of London, in the preparation of which the aid of the most accomplished palæontologists of England was obtained in their various departments.

The results of all these researches are presented by the author in a condensed form in the work now before us, an octavo of 523 pages, evidently prepared with the object of posting up the geology of the palæozoic formations to the present time and presenting to the public a volume which should not be too strictly scientific to interest any but the professional geologist, and which, at the same time, might not, like the works previously mentioned, be inaccessible to many on account of its great cost. For this purpose, the original plates of fossils drawn by Mr. Sowerby and engraved for the "Silurian System" have been reproduced by transferring to stone, with the exception of the corals, which being originally lithographs could not be thus made use of again. These latter however have been, with additions and corrections, drawn upon wood, and numerous species are also figured in this way which have been found in Great Britain since the "Silurian System" was published, or of which better specimens have been obtained; these were drawn on wood by Mr. Salter. Thus the "Siluria" is declared by its author to be "a faithful outline of his previous labors and also of our present knowledge of the older palæozoic rocks as registered in the noble series of organic life collected in the Government Museum of Practical Geology."

Having thus noticed the successive publications of our author, it is proposed to glance at some of the principal results and opinions which are discussed in the Siluria, with especial reference to the light thrown on them by the researches of geologists in other countries, and particularly in the United States.

The author of the "Silurian System" has been very much troubled during the last ten years, by the pertinacity with which his old friend and fellow-laborer, Prof. Sedgwick, has insisted on robbing his favorite system of its lower half in order to make out a "Cambrian System." The controversy on this subject has been warmly carried on by both parties and their respective friends. Its history is briefly this: While Murchison was investigating the geology of the border counties of England and Wales, the typical "Siluria," Sedgwick was equally hard at work in North Wales; both of these distinguished geologists having the same object in view, namely, the unravelling the order of succession of the lower palæozoic strata. Apart from all considerations of personal qualifications for success, it is evident that the region selected by Murchison was better adapted for the purpose to be obtained. The rocks of North Wales are so much broken up and invaded by igneous masses, and hence so complicated in their stratigraphical relations, and moreover so poorly supplied with fossils, that it has required all the skill of the government corps of geologists, working out every thing in the most detailed manner, to determine the structure of the region. Hence, while Murchison had elaborated his views and divided the Silurian rocks into a number of groups, which have, in the main, been recognised by the Government Geological Survey, and, what is of still higher importance, had caused the typical organic forms of his system to be described and figured, thus enabling geologists in other parts of the world to identify rocks of the same age, Sedgwick had made but little progress in his district, and certainly had not published a sufficiently clear account of his Cambrian rocks and their fossil contents to enable geologists to recognise them as forming a distinct system. The name Silurian has therefore been almost universally adopted; and when it was found that Sedgwick's Cambrian was nothing more nor less than Lower Silurian, the latter name had already become too familiar to make it possible, had it been desirable, to exchange it for another. Murchison did, indeed, on the authority of Sedgwick, for a time admit that the Cambrian rocks were distinct from and lower than his Lower Silurian; but he soon became convinced that this was an error, as has since been proved by the government geologists, who have demonstrated that the supposed lower rocks of North Wales are physically and palæontologically identical with the groups of Siluria. Unfortunately, as we think, the name of Cambrian has been retained by the British Geological Survey and is now applied to the non-fossiliferous rocks, below an arbitrary base line, in which no fossils have as yet been found. The sandstones of Barmouth and Harlech, the slates of Llanberis and the conglomerates, grits and schists of Longmynd are included in the Cambrian as at present understood. These rocks, however, are not unconformable with the fossiliferous beds lying directly over them, and if hereafter, they should be found to contain organic remains and these should be Lower Silurian types, then the name of Cambrian would have to be dropped.

The whole space occupied in England and Wales by rocks supposed to be azoic is very small, only a few patches being colored as Cambrian on the geological map accompanying our author's work; and should any or all of these beds prove to contain a few traces of organic life, it need not excite surprise, or at all invalidate our belief in the existence of a system of sedimentary beds destitute of organic remains in other parts of the world. Geologists have, indeed, been generally unwilling to admit that in the Lower Silurian we have reached the lowest zone of organic life, and with a few exceptions in Europe, among which the most prominent names are those of Barrande, d'Orbigny and Murchison himself, the name *azoic* has been rejected in its application to the lower unfossiliferous rocks, as implying what could not be proved, namely, that we had positive evidence of the deposition of sedimentary beds previous to the appearance of organic life upon this earth. Murchison was the first to distinctly set forth the theory that in the lowest Silurian strata we have the first representatives of organized existence, that we are justified in asserting that a base line may be drawn from which palæontological reasoning may start. In his "Russia and the Ural Mountains" (1845) he thus expresses himself: "On this point, we have recently convinced ourselves, by clear and indisputable sections, that the lowest beds (Scandinavian) charged with anything like animals or vegetables, are the exact equivalents of the Lower Silurian strata of the British Isles, and that these have been distinctly formed out of, and rest upon, slaty and other rocks which had undergone crystallization before their particles were ground up and cemented together to compose the earliest beds in which organic life is traceable. To the crystalline masses which preceded that palæozoic succession to which our remarks were mostly directed, we apply the term "Azoic," not meaning dogmatically to affirm, that nothing organic could have been in existence during those earlier deposits of sedimentary matter, but simply as expressing the fact, that in as far as human researches have reached, no vestiges of living things have been found in them, so also from their nature they seem to have been formed under such accompanying conditions of intense heat and fusion, that it is hopeless to expect to find in them traces of organization." In the Siluria the author seems to have partly abandoned this ground, since he speaks (p. 458) of the lowest sedimentary strata as being "*almost entirely* Azoic, the heat of the surface of those earlier periods having been, it is supposed, adverse to life." He has also hesitated about giving the name of "Azoic" to his lowest rocks and has adopted the term "Longmynd or Bottom Rocks." This change of opinion in the face of the large amount of evidence in support of the existence of Azoic rocks in various parts of the world which has accumulated in the last few years, is due, probably, to the discovery of a vestige of organic life in the purple and greenish greywacke of Bray Head near Dublin, a rock which is believed by the Government Surveyors to occupy the same place in the series as the rocks previously classed as Azoic on the other side of the channel. This most ancient Irish fossil is a peculiar zoophyte, in regard to which but little is known, but which has been called by Edward Forbes *Oldhamia;* two species of it have been detected. Before asserting that the discovery of this polyp renders the rejection of the azoic system a matter of necessity, it must be recollected that the geological structure of the district in which it occurs is very complicated, and that the strata have been so folded together and invaded by igneous rocks from the lowest known strata up to the Upper Silurian, that it is with difficulty that the true succession of the formations can be made out, while the space occupied by those rocks which are designated the "Bottom Rocks," is so small when compared with the immense development of the Azoic in other countries, that it seems hardly proper to accept this as the typical region of the lowest formations. We see no difficulty in admitting that none of the Welch rocks are older than the Lower Silurian, while we regard the evidence of the existence of an azoic system in other parts of the world as too strong to be easily set aside. The thickness of the Lower Silurian rocks may be increased to an almost indefinite extent by intercalated trappean masses and volcanic grits and conglomerates. This is not only exemplified in North Wales, where the trappean and Bala groups, which are made of a succession of black slates, with occasional bands of sandstones and grits and great masses of trappean rocks and a few bands of limestone containing Lower Silurian fossils, reach the enormous development of 24,000 feet, but in this country, in the basin of Lake Superior, where the lower member of the Silurian, the equivalent of the Potsdam sandstone, which in its normal condition, at a distance from volcanic disturbances, is composed of a few hundred feet of fine-grained sandstone, in the region of trappean outbursts, acquires a thickness, with its associated trappean rocks and conglomerates, of at least three miles.

The whole course of geological investigations since the publication of the "Silurian System" seems to us to have accumulated so much evidence in favor of our having reached in the Lower Silurian the commencement of the existence of organic life on the globe, that this is to be accepted as one of the great results of the science, at least until some vestiges of a Fauna or Flora of an older type shall have been discovered. There can be no fact more unequivocally made out than the extraordinary resemblance everywhere manifested in the Fauna of the oldest fossiliferous rocks. Throughout the whole extent of the earth's surface which has been explored, we find that there is in the Lower Palæozoic types, as we descend in the series, a more near approach to identity in fossils of remote localities but of the same geological period. In the Bohemian basin, whose geology has been so elaborately worked out by Barrande, this geologist describes, at the base of the fossiliferous beds, a series of schists, conglomerates and undoubted sedimentary strata, in which not a trace of organic life can be discovered, and which he does not hesitate to designate as Azoic. These he divides into two groups, of which the upper one is not to be distinguished from the overlying fossiliferous beds either by stratigraphical position or mineralogical characters, resembling in that respect the Longmynd or bottom rocks of Siluria. Above the Azoic rocks rests the group of argillaceous schists containing a set of fossils, designated by Barrande under the name of the "Primordial Fauna." This Fauna is mostly made up of trilobites of the genera ***Paradoxides***, ***Conocephalites***, ***Ellipsocephalus***, ***Sao***, ***Arionellus***, ***Hydrocephalus***, and ***Agnostus***, with which are associated a Pteropod, an Orthis, and two Cystidians or analogous bodies. Of the seven genera of trilobites above mentioned, only one, *Agnostus*, is found in an overlying group; all the others disappear forever with the eruption of a vast mass of porphyry which separates the "Primordial Fauna" from the "Second Fauna."

Both Barrande and Murchison agree in considering the "Primordial Fauna" to be represented in Great Britain, although not as sharply limited as in Bohemia, by the so-called Lingula beds of Wales, which contain *Paradoxides*, *Conocephalus*, *Agnostus*, and *Lingula*, and by certain beds in the Malvern Hills, containing *Olenus*. The same genera are typical of the lowest band containing organic life in Scandinavia, where the Azoic rocks are developed over an immense space and everywhere recognised as unconformable with the fossiliferous strata. The number of species of trilobites in the Primordial Fauna of this region is very great, but they have not yet been as thoroughly studied as those of Bohemia. The lowest zone of organic life, however, is occupied by fucoids only.

In this country we recognise the existence of the Azoic System over an immense extent of teritory in the Northwest. The fact that the Lower Silurian sandstones rest upon the upturned edges of the older unfossiliferous rocks, in an almost unaltered condition and in the very position in which they were first deposited, renders the study of the relations of the two systems a very intesting one.* In the Azoic rocks we have slates, ripple-marked quartz rocks, and occasionally thin bands of limestone with interstratified traps in immense masses, the whole being so folded over and metamorphosed as to render any estimate of their entire thickness but little better than a mere guess. These rocks extend far to the Northwest, but are much covered by heavy accumulations of drift, and, being in an almost uninhabited country, have been but little explored in their details. In Missouri, the oldest fossiliferous beds, which are of Lower Silurian age, but whose organic contents have been but little studied as yet, rest unconformably on altered sedimentary rocks and porphyries, and the same is said to be the case in Arkansas. In the Lower Silurian sandstone of Lake Superior the few relics of organic existence which have been found have a marked analogy with what has elsewhere been observed in the oldest fossilifeous rocks. The only trilobite thus far observed is a *Paradoxides* or a closely allied genus; besides there are a few fucoids and *Lingula*. Farther west, however, in the same sandstone, on the St. Croix river, a series of trilobite beds, lying at the base of the fossiliferous formations, has been discovered by Dr. D. D. Owen, in the drawings of which Barrande has recognised forms either identical with or in the highest degree resembling *Paradoxides*, but of which the fragments figured in

* Murchison has been, in several instances, led into great errors by adopting M. Jules Marcou as one of his American authorities. Thus he has failed to recognise the unconformability of the Lower Silurian and the Azoic in the Northwest, a well-established fact. We take the liberty of referring the author to Silliman's Journal for March, 1854, where he will find Mr. Marcou's geological knowledge of the United States discussed, and we have little doubt that, after examining that article, he will prefer to consult more reliable authors.

Dr. Owen's Report are too imperfect to allow of their generic position being fixed with certainty. Barrande also discovered on a specimen of the St. Croix sandstone a Pteropod nearly allied to the ***Pugiunculus primus*** of his primordial Fauna. Add to these the ***Lingula***, and the closely allied forms of ***Orbicula*** and ***Obolus*** and we have, with the fucoids of the Lake Superior and New York sandstones, a fair representation of the primordial Fauna.

The unity of the system of organic life below the coal is very evident, and the great difference of opinion as to where the lines dividing the whole palæozoic series into groups ought to be drawn proves sufficiently the difficulty of breaking up the system into parts. The Devonian System was proposed by Sedgwick and Murchison about the same time as the Silurian, and embraced a series of rocks intermediate in position between the upper Silurian and the Carboniferous. The fine-grained limestones and slates of Devonshire were regarded by these geologists as contemporaneous with the Old Red Sandstone of Scotland, the rocks of Devon and Cornwall containing shells and corals of both Upper Silurian and Carboniferous types, while the Old Red is rich in fossil fishes. We have in this country found it very difficult to reconcile our geology with the views generally adopted in England in regard to the Devonian. As has been shown by James Hall, our formations can with difficulty be brought into parallelism with those of England, as long as the systems and groups remain with the limits which they have generally been regarded as having among the geologists of that country. The latest investigations, however, seem to have thrown new light on this subject and when the detailed examination of the groups in the south of Ireland which are intermediate between the Carboniferous and the Lower Silurian shells have been published, we may hope to be materially aided in our comparisons. At present, Mr. Sharpe considers the South Devon limestones as the exact equivalent of the limestone of the "Système Eifelien" of Dumont* and therefore above the Old Red Sandstone. The Eifelian is intermediate between the Condrusian and Ahrian systems, of which the former is represented in England by the Carboniferous series together with the Culm measures of Devonshire, including the Petherwin and Pilton beds, which Mr. Sharpe removes from the Devonian to the Carboniferous. The Ahrian and the next inferior system, the Coblenzian, which are intermediate between the Old Red Sandstone and the Silurian, have not been recognised in England, but are considered to be represented in New York by the rocks between the Oriskany sandstone and the sandstone and shales of the Catskill Mountains. In the Devonian, as at present limited in England, the proportion of Silurian and Carboniferous species is so

* This geologist employs the term *système* as the equivalent of group, or subdivision: *terrain* is his word for system as usually understood.

enormous that, as Hall justly remarks,* "the small number of restricted species reduces the importance of the system to the value of some of our subordinate groups." D'Orbigny, however, considers that the great number of species heretofore considered identical is due solely to incorrect determinations.

Where in England the line between Upper and Lower Silurian shall be drawn is another question which seems by no means satisfactorily settled, although Murchison remarks that "it was at the summit of this Caradoc sandstone that I long ago drew the line of demarkation between the inferior and superior masses of the Silurian systems and observations extended to many distant regions have confirmed the general truthfulness of that division." In the original classification of the Silurian by Murchison, the Caradoc and Llandeilo groups were bracketed together as Lower Silurian, and in the Siluria we are reminded that all the fossils which most frequently occur in the heart of the Caradoc formation are found in the Llandeilo, and yet the Government Surveyors have decided that the Caradoc must be taken from the Lower Silurian and placed as an intermediate group between that and the Upper division, at the same time allowing that the two cannot be palæontologically separated from each other. Sedgwick and M'Coy have shown that the rocks colored as Caradoc in the Malvern Hills by the Government Survey are filled with Wenlock fossils. Partly as a result of this confusion, we find figured in the Siluria, as characteristic of the Lower Silurian a number of fossils which in this country are universally recognised as Upper Silurian only; for instance, *Pentamerus oblongus*, *Halysites catenulatus* (*Catenipora escharoides*), *Favosites Gothlandica* and others.

The map attached to the Siluria, on which is represented the extent of the palæzoic rocks throughout the world, shows the remarkable fact that these, together with the Azoic or crystalline rocks, cover by far the larger part of the earth's surface. Judging by the eye it would appear that of the regions whose geology is approximately known, not more than one-fifth or one-sixth of the surface is occupied by the Mesozoic and Cainozoic, or Secondary and Tertiary, strata. It will not escape any one's notice that the predominating rocks in high northern latitudes are palæozoic; as far north as the most adventurous explorers have penetrated, Silurian and Carboniferous fossils have been found amid eternal snow and ice. The great uniformity in the character of organic life over so vast an extent of the globe during the palæozoic epoch, indicating, as it does, climatic conditions of a very different character from those which now prevail, is one of the most interesting of the revelations of geological science. The very small development of the older fossiliferous rocks in the equatorial zone

* Foster and Whitney's Report, Part II, p. 312.

is another important fact which seems to us to indicate that the conditions for the growth of organic life in that part of the earth were unfavorable during the earlier periods of animal and vegetable existence. If the internal heat of the earth be adopted, as is done by most geologists, as the principal cause of the more uniform and elevated temperature of the globe during the earlier geological periods, is it not a legitimate inference to conclude that the same causes which rendered the now frozen arctic zone sufficiently warm to support a prolific growth of plants and animals, must have so increased the temperature of the equatorial regions that life could not exist there except under peculiar and exceptional circumstances? Thus, the colder portions of the earth are by far the best provided with coal, and within the limits of the torrid zone there seems to be almost a total want of the proper coal-measures.

The order of the palæontological development of the palæozoic strata can nowhere be so well studied as in North America. The vast space over which the older fossiliferous rocks are spread out and the fact that, in spite of the immense period since the animals and plants entombed in them lived and flourished, they remain almost in the same position in which they were originally deposited, are two strong reasons why this study should be carried on in this country with vigor and success. The labors of James Hall have already shed a flood of light over this, the most interesting, department of our geology, and we look on the volumes of the "Palæontology of New York" as a not less important contribution to our knowledge of the palæozoic world than those of Murchison or Barrande. Much yet remains to be done in our great western valley, before our acquaintance with the history of the development of organic life in our older strata will have reached anything like a satisfactory stage. When the various groups, which have been so thoroughly studied in New York by Hall, shall have been equally well worked out in their western and southwestern extension, we shall have a more complete picture of palæozoic life, as developed under every variety of physical condition, than any part of Europe can furnish. Thanks to the labors of Mr. Logan in Canada, we are fast gaining a knowledge of that interesting region thus getting a clue to some of the intricacies of New England geology, so that we may hope that so large a part of our northeastern states will not always remain but little better than a blank upon our geological maps.

The subject of the original formation and distribution of gold over the earth's surface is one in which Murchison has, since his visit to the Ural, been particularly interested, and a chapter of the Siluria is devoted to a recapitulation of what he has elsewhere published in regard to it. In 1844 our author was led, principally by an examination of specimens collected by Count

Strzelecki along the eastern mountain range of Australia to infer that there was a strong resemblance between that region and the Russian auriferous chain, and he adverted to this in his address before the Geographical Society in that year, suggesting that gold would probably be found there. It had indeed been already discovered by Strzelecki, as early as 1839; but at the earnest request of the Governor of New South Wales this gentleman has kept the matter a profound secret.* In 1846 Murchison received specimens of auriferous quartz from that region, and he again enlarged on the analogy between the Australian Cordillera, as he termed it, and the Ural chain, urging the Cornish miners to go out and seek their fortune as gold washers in that distant country.

Since that time, he has written numerous papers, the chief object of which has been to set forth the facts of his connection with the gold discoveries in Australia and to show that the public need be under no apprehension of a fall in the value of the precious metal, on account of its immensely increased production since the opening of the auriferous regions of California and Australia. This increase, according to Murchison, can only continue for a short time, since the records of mining have shown that auriferous veins rapidly decrease in richness from the surface downwards, so that they cannot be worked with profit, while the detrital beds, from which almost all the gold is obtained, are necessarily limited in depth and are therefore soon exhausted, especially when Anglo-Saxon energy is directed to their exploration. Our author's predictions have been more completely sustained in the case of Australia than in that of California. The yield of gold from the former country is already falling off rapidly, but the Californian gold-fields, although they were attacked four years before those of Australia are still yielding only a slightly diminished quantity. Still there is no doubt that the maximum of production has been reached, and that there will be a decline, probably slow and gradual, but still inevitable. It seems hardly possible to avoid the conclusion that enough gold will have been obtained in the course of the twenty years following the opening of California, to produce a sensible effect in depressing the value of the precious metal. The auriferous sedimentary and detrital beds are accumulated on a more gigantic scale along the flanks of the Sierra Nevada than anywhere else, and a very considerable time must elapse before they will have become exhausted of their metalliferous contents, while it is by no means proved

* It is worthy of note that the authorities of New South Wales again and again endeavored to suppress the knowledge of the existence of gold in that region, lest it should interfere with sheep-growing. Although Strzelecki was actually the first to find gold; yet, practically, the discovery is due to Mr. Hargraves, a "returned Californian," who with a little of the "go-ahead" spirit brought from the other side of the world commenced "prospecting" and digging, without much regard for governors or sheep.

that a very considerable amount of the precious metal may not be obtained from workings in the veins themselves, if properly and economically managed.

Within the last few years, the ratio of the production of gold to silver has undergone a great change. Early in the present century it was by weight nearly as 1 of gold to 43 of silver; in 1845 when the Siberian washings were most productive, the ratio was 1 : 17 ; in 1852, when California and Australia were yielding most largely, it was as 1 : 4. It has been generally admitted by writers on political economy, that so great a change as this in the relative amount of the two metals brought into use must have an effect on their relative values, and that silver must gradually rise to something approaching the value which it formerly had as compared with gold. Murchison however has the extraordinary idea that "Providence seems to have originally adjusted the relative value of these two precious metals and that their relations having remained the same for ages, will long survive all theories." He seems to forget, that the opening of the silver mines to South America in the sixteenth century so increased the produce of that metal as to depress its value, as compared with gold, from a ratio of about one to ten, which it had maintained for a long period, to one to fifteen. Since the earliest historical times the relative value of the two noble metals has always been more or less fluctuating, and, being dependent on the varying influences of demand and supply, it will no doubt always continue so; although, except under extraordinary circumstances, such as the discovery of the California gold-fields may be conceived to be, usually vibrating within narrow limits.

The last chapter of the Siluria is chiefly devoted to a general view of the succession of life from a beginning, as based on positive observation, carefully distinguishing absolute geological results from mere theoretical speculations on what may hereafter be found. The idea of a progressive development in animal and vegetable life, which was for a time so stoutly battled against, seems to be more generally recognised. It is now seen that in the general anxiety which once prevailed among geologists to bring down the higher types of organized existence into the lowest strata, a good many mistakes were made, which more careful observations have set right. Thus the famous tracks in the Potsdam sandstone of Canada, which were once so confidently pronounced to belong to *Chelonians*, are now regarded as *Crustacean*. At one time we were led to believe that fishes made their appearance as low down in the series as the Lower Silurian, and this was strongly insisted on as opposed to the theory of progression. It now seems, however, to be almost certain from the comparison of observations made all over the world, that it is not until we rise to the uppermost beds of the Silurian System that we find traces of vertebrate life, in the form of a few minute fishes. In England the earliest fishes are now supposed to occur in the upper Ludlow, the so-called "fish defences" in the lower rocks, having been shown to be crustacean. The fragments of jaws, teeth and skin found in the "bone-bed" of the upper Ludlow, however, do not seem to be capable of being referred with absolute certainty to the class of fishes, since the opinions of palæontologists are divided with regard to the larger part, if not all, of them.

Our author, therefore, seems to us justified in asserting that, looking at the Silurian System as a whole, we know that its chief deposits (certainly all the lower and most anterior) were formed during a long period, in which, while the sea abounded with countless invertebrate animals, no marine vertebrata had been called into existence; that these may yet be found is certainly not impossible; but every year of active exploration all over the world diminishes the probability of such an event, and should make us more unwilling to accept as a fact any supposed discovery of the kind, unless substantiated by undoubted evidence.

In taking leave of our author, we feel strongly impressed with the change which under his guidance, has been wrought in our knowledge of the lower fossiliferous strata during the last few years; the impulse which his labors have given to palæozoic geology is everywhere felt and acknowledged. Still we close the pages of the "Siluria" feeling quite as deeply that if much has been done, much more remains to do; the outlines have been drawn upon the canvass, but the perfect picture will only be the result of long-continued and associated labor. The geologists of this country especially have a noble task before them; their field is almost unlimited, the results must be proportionally grand.—J. D. W.

ART. XXXVIII.—*Barometric Anomalies about the Andes;* by Lieut. M. F. MAURY, U. S. N.*

LIEUT. HERNDON, U. S. N., in his descent of the Andes, in 1851–52, on his way from Lima to explore the valley of the Amazon and to descend that river to the Atlantic, determined the heights of various places above the level of the sea, both by barometric pressure, and by the boiling point of water. His boiling apparatus was constructed by Mr. Wm. Wurdemann, of Washington.

His observations as to atmospheric pressure, made with the view of determining heights above the sea level, appear to indicate

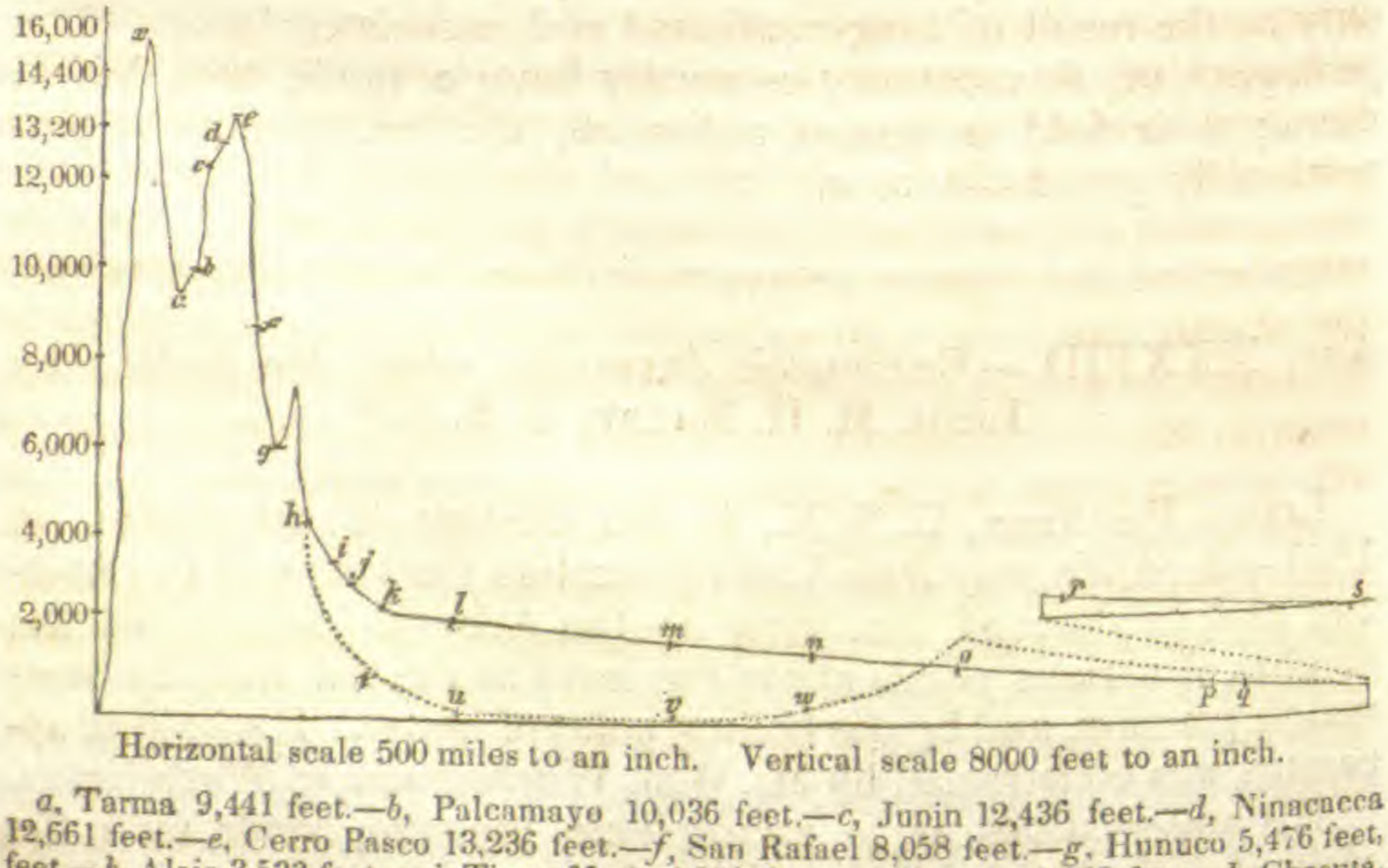
* From Maury's Sailing Directions, 4to, 1853.

that the form or shape of the Andes is repeated in the atmosphere. In other words, that there is in the region of the clouds, a ridge or pile of atmosphere, answering to an air-cast mould of the Cordilleras; for at the eastern base of the Andes he found the pressure of the atmosphere, as measured by the temperature of boiling water, to be nearly as great as it is usually at the sea level—and after having descended the river for nearly a thousand miles below this place of great pressure, he found that, according to the boiling point, he had ascended nearly 1,500 feet!

These mountains extend from three to five miles up into the atmosphere. The Trade Winds blow almost perpendicularly against them. Of course, these winds are obstructed by an obstacle, which extends as far up, or nearly as far up, as they themselves do; and, being thus obstructed in their course, would there not, consequently, be a banking up of air against the Andes, as there is of water against a rock or other impediment, over which the current of a rapid river has to force its way? In such cases, there is a ridge or pile of water above the obstruction, and a depression or hollow in the water both above and below this ridge.

Herndon's observations on the boiling point of water, have suggested to me the idea of an air-cast mould of the Andes in the atmosphere; in other words: that there is to windward—that is, to the eastward of the Andes, where the trade winds first impinge—an accumulation or ridge of atmosphere, with a valley or depression on each side of it.

To illustrate this, I have had a diagram drawn, upon the supposition that the average descent of the Amazon from Chasuta, at



Horizontal scale 500 miles to an inch. Vertical scale 8000 feet to an inch.

a, Tarma 9,441 feet.—*b*, Palcamayo 10,036 feet.—*c*, Junin 12,436 feet.—*d*, Ninacacca 12,661 feet.—*e*, Cerro Pasco 13,236 feet.—*f*, San Rafael 8,058 feet.—*g*, Hunuco 5,476 feet, feet.—*h*, Alajo 3,533 feet.— *i*, Tingo Maria 1,923 feet.—*j*, Tocache 1,253 feet —*k*, Chasuta. —*l*, Santa Cruz.—*m*, Nauta.—*n*, Pebas.—*o*, Egas 1,715 feet.—*p*, 50 miles above Barra.—*q*, Barra 1,150 feet.—*r*, Villa Nova 638 feet.—*s*, Para.—*t*, 585 feet.—*u*, 177 feet.—*v*, 126 feet.—*w*, 228 feet.—*x*, Antarangra 15,739 feet.

the head of uninterrupted navigation, down to the sea, is 8 inches to the mile. Eight inches to the mile is probably too great a descent from the foot of the last rapid in the Amazon to the sea. But the object of the diagram is not to illustrate the slope of the Amazonian water-shed; it is to illustrate the remarkable degree of barometric pressure that has been found near the eastern base of the Cordilleras. I therefore assume the descent of the river to be on the average, very nearly what Herndon's observations made it to be, after he had passed from under the supposed elevation, or ridge of the atmosphere. The distance from Chasuta to the sea is, by the windings of the river, about 3,285 miles.

The dotted line, shows a profile view of Herndon's descent, according to the temperature of the boiling point; and the continuous line, his actual descent, upon the supposition that the average inclination of the river from Chasuta to the sea is as before stated—8 inches to the mile.

From Nauta, where his boiling point placed him at only 126 feet above the level of the sea, to Egas, where, though drifting down the stream all the way, it placed him 1,715 feet above it, the distance is 707 miles. If intermediate observations could have been made between these two places, he would probably have found that he had passed from under this supposed air-cast range of mountains long before he reached Egas.

However, observations sufficient for a full explanation of the phenomena presented by this diagram are wanting, and we must deal with those we have, as best we may, hoping by calling attention to the subject upon such meagre facts, some other traveller will be provoked into a thorough and complete series of barometric observations along the slopes of the Andes.

Lieut. Herndon assumed that at the mouth of the Amazon, the mean height of the barometer would be 30 in., the boiling point 212°. But during a portion of his descent, the belt of the equatorial calms was over the mouth of the Amazon. All the ships whose Log Books I have with records in them, as to the barometer, show that it does not stand as high in these calms as it does on either side of them. Dewey's observations at Para, confirm this. Therefore Herndon's heights as determined by the boiling point of water during his descent of the Amazon, are probably not so great as the standard, to which he referred his observations, would make them. At any rate, whether his observations were uniformly too great or too small, is immaterial to my present purpose, which is to show the remarkable variations discovered by him in the pressure of the atmosphere, particularly during his descent of the Amazon.

At Nauta, in Peru, which is about 2,700 miles above the mouth of the Amazon, it appears there was an accumulation of atmosphere sufficient to cause a pressure nearly equal to the ordinary atmospheric pressure at the sea level. In other words, this traveller found himself under a ridge or mountain of atmosphere, the pressure of which away up on the side of the Andes was nearly as great as is the mean pressure of the atmosphere down upon the sea shore.

Drifting along down the river from Nauta, Lieut. Herndon, much to his surprise, found that according to his boiling point, he was ascending or going up-hill quite rapidly, though by the river and his own senses, he was descending. Finally, by his boiling point, at Egas, he ceased to ascend, and again began to descend according to it and his own senses also.

It is worthy of remark, that M. Castlenau, the French traveller, who preceded Herndon, observed the same phenomenon with regard to the high barometer, at Nauta, that the American did with regard to the boiling point.

Their measurements, which were both made on a bluff or high bank of the river, differ from each other as to the height above the sea level, 51 feet. At the next place—Pebas—where they both again observed, the difference between them is 138 feet. At Barra also, they both observed. Here, too, the German travellers, Spix and Martius, observed. These observations give the height of Barra, by Castlenau, 293 feet; by Herndon, 1,380; by Spix and Martius, 522 feet; above the level of the sea. M. Castlenau complains that in his descent of the Amazon his barometer got out of order, and that in consequence, he was compelled to reject a portion of his observations. Was it because his barometer made him apparently go *up* hill, as Herndon's boiling point did, when he knew he was going *down* stream?

It is to be hoped, if this should ever meet the eye of that clever French traveller, he will have the goodness to let the world see those rejected observations.

Moreover, it would probably depend upon the season of the year whether barometrical observations along the Amazon, and to the north of it, would detect this supposed repetition of the Andes in the air. When the equatorial calms are upon the Amazon, as for a month or two annually they are, the trade winds do not blow at Nauta or Pebas, consequently there would be no accumulation of air *then*, and from this cause, over those places. But at the other season, when the S. E. trades are felt at Pebas and Nauta, and when they are impinging and pressing against the Andes, I imagine they accumulate and pile up too, and will make the barometer feel the weight of this accumulation. Now, the fact that those travellers passed along the Amazon at differrent seasons of the year, may *help* to account for this extraordinary difference in their barometrical observations.

Reasoning from these facts and conjectures, I have been led to ask the question—that if there be an *elevation* in the atmosphere to windward of the Andes, ought there not to be a hollow or depression in it to leeward of them also? With the view of getting some light with regard to the answer to this question, I have sought to ascertain what is the mean height of the barometer at Lima and along the Peruvian coast of South America. It appears that the mean height of the barometer at Lima is, according to Doctor Unanue, 29·13, (27 *pulgadas*, 4 *lineas*,) with a variation in its range of from 2 to 4 *lineas* (0^{in}·18 to 0^{in}·37). He says the barometer rises 2 *lineas* in the summer, and falls as much in winter. Assuming the mean height of the barometer at the sea level in Callao to be 30 in., Unanue's mean reading would give 765 feet as the height of Lima above the sea. But according to a level run for the railroad between the two places, the height of Lima above the sea level of Callao, is only 496 feet, and until it was thus run, the height of Lima above the sea was generally assumed at what the barometer would make it, viz.: about 750 feet.

The change in the barometric pressure due a height of 496 feet, is one-third of an inch, and this correction being applied to the Lima barometer of Unanue to reduce it to the sea level, would make the mean reading of the barometer at Callao to be 29·46; thus confirming this conjecture, (so far as these scanty observations go,) that the barometric pressure along this part of the coast, is less than that due to its latitude and elevation. Admitting these conjectures to be truths, we derive a practical rule, that the height of a chain of mountains determined by barometric pressure *depends upon the way the wind blows.*

If the standard for comparison be placed at the foot of the mountain on the windward side, the height of the mountain will appear too great; and if it be placed on the lee side, the height of the mountain will be too low.

Lima is far enough, or nearly far enough south, to be beyond the reach of the diminished barometric pressure due to the belt of equatorial calms. But Lima may be under the hollow or depression caused in the atmosphere by the Andes, or rather in consequence of the obstruction which these mountains oppose to the trade winds. The effect of this obstruction, as before explained, is to cause a banking up in the atmosphere on the windward side of the Andes, (as there was found to be over Nauta,) and a depression in the air on their lee side. Whether Lima is under the axis of this atmospherical valley or not, or whether it is on one side or the other of its axis, is a question for actual observation to decide. I shall certainly look for lower barometers in vessels coasting along the shores of Peru, than I would in vessels crossing the same parallels of latitude, but at a considerable distance out to sea.

Upon the same principle and for the same reason, I should expect to find in Southern Chile and Western Patagonia a bank of atmosphere to windward of the Andes, and a depression to leeward—the lee side in this place being the eastern, and the windward side the western side—of the Andes. Now, Lima is in the range of permanent trade winds, and Lieut. Herndon, by assuming the barometer at the sea level of Callao, to be 30·019, would, after leaving that city, make the heights of all places determined by him, from 210 to 380 feet too high with regard to the Pacific, depending of course, upon the season of the year; for the fluctuations of the barometer here are periodical as well as diurnal.

At Para, at the mouth of the Amazon, where we have a low barometer not from mountain agency, but from the effect of the equatorial belt of calms upon the barometer, Herndon's heights, except under the remarkable banking up of the atmosphere to the windward of the Andes, are not far from 230 feet too great as compared with the sea level of the Atlantic at the mouth of the Amazon. Assuming the barometer at the level of the sea, for the mouth of the Amazon, to be on the average 30·019, Lieut. Herndon by the boiling point, which agrees well with direct barometric determination elsewhere, makes the city of Para to be 255 feet above the level of the sea.

Para is about 90 miles from the sea, in an alluvial country; it is about 15 feet above the mean tide-water level, and if we suppose that the river has thence to the sea a total fall of 10 feet, (more than an inch to the mile,) we should make Para 25 feet above the sea level. It can scarcely be much more than 25 feet, because we know, or rather because we are entitled to assume that the Amazon has no very great rate of descent near its mouth. Assuming, then, that Para is only 25 feet above the level of the sea, Herndon's mean boiling point at Para, reduced to the sea level, would be equivalent to a mean barometric pressure of 29·64. By the mean of actual barometric observations taken at Para, he makes the barometer at the sea level, supposing Para to be 25 feet only above it, 29·57, his readings being corrected for temperature only.

If the Andes offered no obstruction to the passage of the trade winds—if there were no barometric anomalies resulting from the rising up of this chain of mountains into the air—and if we had a series of accurate barometric readings from Chasuta, (the head of navigation on the Amazon,) down to the sea, we might expect that the elevation above the sea, as determined from such observations, would gradually decrease from the foot of the mountains to the Atlantic. There would in such a series of measurements be expressed, it is true, upon the resulting heights, the effect of diurnal changes of the barometer; and if the person making the observations were to be occupied for several months in descending the river with his barometer, the agency of the periodical barometric changes would also be perceived by their effects upon his determinations of elevation. I am supposing in this case of imagined barometric heights, that such an observer would have no corresponding observations at the sea level, and that the height of the barometer at the mouth of the Amazon would be considered a constant.

The mean monthly heights of the barometer at Para, as observed by Dewey in 1846, 1847, and 1848, and till May, 1849, showed an extreme range of *only* 0·41 in., viz.: from 30·02, which was the monthly mean for July, 1846, to 29·61, which was the monthly mean for September, 1846.

The fluctuations arising from the monthly barometric changes might give the line of descent along the Amazon, as determined in this way, a wave-like appearance, amounting, perhaps, to 300 or 400 feet at most. But in the case before us, the change actually amounted to something like 2,000 feet. For after Herndon had descended the river 707 miles, and approached with its current the sea level 571 feet, he was then 1,589 feet higher than he was when he set off.

We cannot, therefore, well conceive how we could find from such a source as daily or monthly changes in the uniform barometric pressure of Para, such anomalies in barometric determinations, heights, and pressures as were observed.

If the suggestion, that the high boiling point of Herndon and the high barometer of Castlenau at Nauta were caused by the pressure of the Trade Winds against the Andes, should turn out correct, and the barometric observations on the head waters of the Amazon, both of Humboldt and Condamine, tend to confirm it, will not the Andes be converted into an immense anemometer, by which the force of the Trade Winds may be determined; and if their force, consequently their velocity also?

Art. XXXIX.—*Impressions (chiefly Tracks) on Alluvial Clay, in Hadley, Mass.;* by Charles H. Hitchcock of Amherst College.

In the summer of 1852, in company with Mr. E. C. Bolles of Hartford, I accidentally discovered various impressions on a clay bed situated upon the east bank of the Connecticut river directly south of Hadley Centre, and a short distance north of Shepard's Island. The bed lies beneath about twenty feet of alluvial sand, which abounds in ferruginous tubular concretions. By the action of freshets, a large amount of the sand lying upon the clay has been removed, leaving about two or three acres of level surface exposed. The bed itself is close by the place described in my father's (Pres. Hitchcock's) Final Report on the Geology of Massachusetts, as abounding in claystones of remarkable forms.

The impressions are principally found upon muddy deposits made by rains in the irregularities of the surface. The circumstances in which these impressions occur, afford an admirable illustration of the manner in which similar appearances were produced upon what is now solid rock. It is to be lamented that recent tracks were not more studied at the time when it was doubted by men of science whether ichnolites were originally made by animals. In those days of discussion at least one of such doubters was convinced that the impressions were *foot*-marks, by noticing a piece of clay in the cabinet having on it a few tracks of a snipe. Though skeptics are now few on this subject, additional confirmation of the facts and deductions of Ichnolithology may still be of value.

Impressions of thirteen different kinds of animals have been noticed at this locality: viz., of man, four species of birds, two of quadrupeds, one batrachian, snails and annelids, besides two or three of a doubtful character.

The human imprint is one of the most interesting. It is a single impression of a boy's foot, and occurs with two of a crow. Raindrop impressions had been made on the spot before the others had been formed, and were not entirely obliterated by the foot of the boy. All the striæ and lines upon the sole of the foot appear distinctly on the specimens, particularly the fine striæ and ridges. The phalangeal impressions and papillæ of the crow's foot are also strongly marked. The difference between the integuments of the foot of man and birds is finely exhibited: in the former the lines are much finer, and parallel to one another, running mostly across the foot; while in the latter the papillæ cover the whole phalanx with dots, scattered irregularly.

The tracks which I have referred to the crow, may have been made by some other bird. It is a curious fact, that these tracks are frequently more difficult to refer to the true animal than Triassic* impressions. The most common track at this locality is that of the common snipe, *Tringa minuta*. It is four-toed, and about an inch in length. In some places on the bed I have seen

* Prof. Henry D. Rogers (see this volume, page 123) has advanced reasons for supposing that the sandstone of the Connecticut valley belongs to the Jurassic rather than the Triassic series. My brother, also, (Dr. Edward Hitchcock, Jr., of E. Hampton, Mass.,) has recently discovered in this formation fine specimens of the *Clathropteris*, a genus of ferns confined in Europe exclusively to Liassic sandstone. He proposes to describe it in the following number of this Journal. But strong as the probability is that the Liassic sandstone exists in this valley, I have thought it best to use the name Trias. The recent measurement of two sections across the valley by my father, shows a thickness of rock four times greater than either the Lias or Trias of Europe, and leads him to conclude that probably several formations may exist here, which in time may be distinguished.

perfect tracks of this species in rows several yards long, and some have been found in relief, by splitting open the layers of clay. A few thousand years might so petrify the impressions and their casts, that they could not be distinguished from fossil foot-marks, except so far as difference in species is concerned. The tracks of two other species of birds, one of them, perhaps a *Tringa*, have been found; but with no additional character of importance.

Of the two genera of quadrupedal tracks noticed, those of the dog only are recognised. In some specimens, because of the toughness of the clay, the claws merely are impressed. A careless observer might suppose that these canine impressions were made by a biped, because he sees only an apparently right and left foot-mark. But a close examination shows that every track is double: that is, the hind-foot steps into the tracks of each fore-foot. In other cases, instead of being double, the two tracks are placed side by side very near to each other. The marks of hair may be seen on some specimens. The papillæ of the dog and crow are quite similar.

At another place there were impressions in two long rows which were possibly produced by a young bird—the progress of Tringa minuta, perhaps. Others were made by a frog at rest. Of these last, the two largest were made by the hind feet; they are toed in. An oval spot between the tracks was probably made by the body of the animal.

Another class of impressions forms irregularly curved lines. These may have been made by the smaller Conchifers and Mollusks, Unio and Paludina: of course, different species which were of the same size could not be distinguished from each other by their tracks.

The trackway of an Annelid is very distinct. It is a continuous fimbriated trail, depressed in the centre throughout its whole extent and elevated along its edges. At least two species have been noticed. Of these daguerreotypes have been taken as well as of some others; and we find this an admirable, though somewhat expensive, mode of preserving them.

Raindrop impressions and *air-vesicles* have been found in abundance. They are more fully noticed beyond.

From the facts obtained at this locality we derive a very clear idea of the manner in which foot-marks on stone were produced.

The surface of the denuded clay is somewhat uneven. Every time it rains the depressions become filled with water, thus making small pools of muddy fluid, which form a deposit admirably fitted for receiving impressions. Upon this soft stratum, after the water has nearly dried up, animals tread, leaving the imprints of their feet. Subsequently the deposit becomes hardened by the heat of the sun, and the tracks of course remain upon the clay as distinct as when first formed. *Another* storm arises, and a new stratum is brought on, covering up the former layer, without obliterating the tracks. When the water has retired, this second deposit is trod upon, and hardened in the same manner as the first. At the same time the new layer fills up the recently made tracks. Thus an exact cast of the forms of the tracks is produced. A third stratum protects the impressions upon the second deposit, and in this way the process may go on indefinitely. Having dug up and cleared the successive layers, the tracks in relief, as well as the corresponding depressed ones, have been found, as was stated in the description of the foot-marks made by the *Tringa minuta*.

Now let us consider the condition in Triassic times, when the Connecticut valley was an estuary. Upon its shore after a plentiful rain, birds and other animals were scattered along in search of accustomed food. The heat of a tropical sun quickly hardens the first stratum impressed with tracks. Another shower comes, or more probably the tide rises, and a second layer is brought on, covering up the impressions just formed. This too in turn receives the impress of feet and becomes hardened, as may also others in succession till the sandstone of the whole valley above the tracks, at least a mile thick, was deposited. And since animals seek their food chiefly along the margin of the water, we find the rock, usually over only a few feet in width, impressed with tracks.

The correspondence between the alluvial and Triassic impressions extends to every minute point. In both formations appears the same alternate order of right and left foot. They are found in relief in each instance. The phalangeal impresssons are analogous in both periods. The print of the claws, also, is quite distinct upon stone as well as clay.

Tetrapodal ichnolites find alluvial counterparts at this locality. The form of feet and manner of gait of the Dog and *Anisopus Deweyanus* somewhat resemble each other. The fore-feet however, in the fossil species, are much smaller than the hind. But the impressions, instead of being situated at an equal distance from each other, are arranged by twos—a large and a small track together. This peculiar arrangement arises from the structure of quadrupeds, and the rapidity with which the animal moves. The swifter the movement the more nearly the hind foot is brought into the place of the fore one.

The tracks of a frog correspond well with the ichnolites of the *Anomœpus scambus*. There are specimens of the impressions of this animal in the cabinet of Amherst College, proving it to be a huge batrachian in a sitting posture, and like the specimen on clay. The impressions of the Conchifers and Mollusks upon the clay, illustrate the *Herpystezoum Marshii* and *H. minimum* of the fossil foot-marks. No difference in character between the Triassic and alluvial specimens has been noticed.

The trails of Annelids have been found upon stone. Reference is made to those upon the Clinton group of the New York Silurian rocks, described in the 2d volume of the Palæontology of New York, page 30, 31, figures 13 and 14. Some differences exist between the impressions occurring in the different formations. But much of the diversity may be referred to the disparity of size in the animals, and the partial filling up of the fossil trails with sand.

These tracks afford a presumption respecting the time of man's appearance upon the globe. Among these impressions in Hadley as already mentioned, are those of man. Now, if he had lived when ichnolites were formed, it is probable that he would have left similar traces of his existence on stone: but in the whole series of rocks below the alluvial, no tracks made by human feet have been discovered.

The phenomenon of raindrops on stone receives a beautiful illustration at the Hadley locality. These are preserved most perfectly when it barely sprinkles. In a heavy or long continued shower, so many impressions are made, that they coalesce, and leave no distinct trace of their separate existence. The surface in this case resembles a chopped sea. Specimens of raindrop impressions denoting every variety of shower, have been found upon stone and upon this alluvial clay. In no particular are they dissimilar. On page 502 of the Final Report on Geol. Mass., it is stated that some specimens of raindrop impressions denoted the direction of the wind when the mud was sprinkled. The alluvial depressions indicate the same fact, though less perfectly; owing of course to the want of strength in the wind.

The Hadley clay furnishes another appearance so similar to raindrops as to be mistaken for them, and which has led some geologists to doubt the existence of fossil rainmarks. *Air-vesicles* are sometimes found scattered like raindrops over the surface. These are of course swelled upwards. By this mark they can always, when the surface has been undisturbed, be distinguished from raindrop impressions. But when the clay dries, the air escapes, and the vesicles collapse, and may even sink below the surface. The gas in the vesicles probably proceeds from the partial decomposition of organic matter in the clay. That organic matter also mixed with the clay, forms a thin film at its surface, which is raised by the gas into pustules.

Another kind of impression common to stone and this clay is that of ripple marks. These are formed by the action of waves upon the bottom, arranging small quantities of sand and clay in continuous ridges. Specimens of ripple marks upon stone and those observed on this clay bed exactly resemble each other in form and size.

It may be added that we have found at this locality large surfaces covered with scratches similar to the striæ made upon stone by drift. Hence we infer that the latter may sometimes have been made in a similar way. In the spring, the Connecticut river is swollen to an unusual size, and filled with masses of ice and floatwood. Driven by the current, they are forced over this bed while it is scarcely covered by the water. And thus the surface becomes covered with striæ: all pointing in the same direction except a few which cross the others at a small angle.

The phenomena of *mud-veins* are also illustrated by a fact noticed at this clay bed. Great heat causes clay to contract, as may be seen in deposits left by small pools of muddy water, which have been exposed to the sun. The surface of this bed in Hadley is similarly divided during seasons of drought. So when in Triassic times a clayey mud was cleft in this way, the returning tide, or a storm of rain would fill the fissures with detritus, producing the *mud-veins* which are very common in the rocks of the Connecticut valley. Another fact may be mentioned here. The summers during which the best specimens of these alluvial foot-marks were obtained, were quite dry. If a long drought succeeded a copious shower, a fine crop of tracks was gathered. Hence it may be inferred, that when the Triassic ichnolites were made, the climate was tropical. This will explain the remarkably fine preservation of delicate ichnolites.

This locality serves to explain why among so many fossil footmarks as have been disinterred, scarcely a relic of the animals themselves have been found. For three years I have not noticed on this clay bed any other trace of the animals besides their tracks.

As this seems to be the common *feeding-ground* for many species, if any of them died there, their remains would probably have been devoured or floated away by the water. Such a spot therefore, is the least likely of any to contain organic remains. As it seems to be a type of the spots where fossil footmarks occur, we may reasonably infer that the paucity of such remains in the Triassic rocks is not strange.

Art. XL.—*Emmons on American Geology.**†

The laborious investigators of our American geology can scarcely find time for the preparation of popular treatises, which shall embody the results of their researches, and the consequence too often is that this labor is left for those who are most unfit for the task. It is but a few months since another pen than ours called attention to Mr. Marcou's poor caricature of a geological map of North America, and showed that both the map and the accompanying text are full of errors and mis-statements, calculated to give foreign readers most erroneous ideas, not only of the state of American science, but of the true geological structure of the country. We recall this with more regret, because we observe that Sir R. I. Murchison was deceived by Mr. Marcou's pretensions, and lent to the map a certain sanction in the pages of Siluria, before he was apprized of its worthlessness. The fact that Mr. Marcou is a comparative stranger in our country may explain his ignorance though not his presumption; but we regret to say that no such excuse can be urged in behalf of the author whose name appears at the head of this article. Dr. Ebenezer Emmons is known to the American public as having been the geologist charged with the examination of the northern district of the State of New York, and as the author of the so-called Taconic System; besides which, as geologist to the State of North Carolina, he has given us two or three reports, which we may notice further on. With these antecedents, he presents to the world the first part of a work on American Geology.

The author seems to have sat down to his task without any well defined plan, and hence the promiscuous arrangement, repetitions, obscurities, and contradictions of the volume. As to scientific accuracy, style, or even English grammar, the work is filled with errors. He objects in his preface to the works of American geologists, that they are not American, and proposes to give us a truly American geology. Our readers shall judge how far his work is worthy of such an honorable title.

Passing over his preliminary remarks for the present, let us glance at our author's classification of rocks. Besides the *Hydroplastic* rocks embracing all the sedimentary deposits, and the *Pyroplastic*, including all traps, lavas, etc., we have a third class, *Pyrocrystalline* rocks, divided into laminated and massive, this last embracing "granite, syenite, hypersthene rock, serpentine,

* American Geology, containing a statement of the Principles of the Science, with full Illustrations of the characteristic American Fossils; to be completed in four parts, with an Atlas and a Geological map of the U. States; by Ebenezer Emmons. Part I. Albany, 1854.

† The Editors make no apology for inserting a review of another of Dr. Emmons's works, other than the fact of its recent publication and its especial claim to notice.

rensselaerite, and octahedal iron ore," besides what he calls *pyrocrystalline limestone*, as distinguished from *laminated limestone*, which he however places in the laminated division of his pyrocrystalline rocks, with *laminated serpentine*, gneiss, mica slate, hornblende, talcose slate, etc., p. 43. He here objects to the name of metamorphic rocks as applied to gneiss, and the subsequently named rocks because "its use is theoretical, and was thus applied on the hypothesis that those rocks are altered sediments, *of which there is no evidence*." The italics are our own, but we shall let the author explain his notions of the origin of these pyrocrystalline rocks, which he tells us have been produced by the consolidation of the earth's crust.

"A pellicle must have ultimately been formed, *and which* still maintains its existence as a constituent part of it. From the manner in which the surface cools, the consolidated masses which successively form, must lie in contact with the inferior surface of the first-formed pellicle. The thickness of the crust increases from below."

So that the order which is observed in the hydroplastic rocks is inverted, and "the newer are beneath and the older above."—p. 45.

On the next page we are told that the first formed rocks are the most highly crystalline, because the heat of the earth was greatest at the epoch of their formation. We are at a loss to conceive what greater heat than that of a central fused mass can be required, or what better condition for crystallization can be conceived than that of a mass slowly congealing between the outer crust and the central fire. We are then told that granites are the first products resulting from the cooling of the earth's crust; as a consequence of the inverted order of succession already described, it would follow according to our author that granites should overlie all the other pyrocrystalline rocks, which we should find beneath it, arranged in consecutive layers, the least crystalline ones, like talcose slates, serpentines, lowest down! He further adds, "traps, and greenstones, never form those parts of the earth's crust which belong to the most ancient periods—the rocks of the most ancient periods being represented by granites and gneiss, whose structures are eminently crystalline."

The author, while he finds it difficult in speaking of veins and dykes of granite, (whose subsequent intrusion he admits,) to distinguish this rock from his pyroplastic group, is not less disposed in the next paragraph to class greenstone with granite as a pyrocrystalline rock. Further on, serpentine, whose pyrocrystalline nature he has already asserted, is spoken of as an igneous rock, which, like other rocks of this class, has been formed at different periods. Quartz rocks, even when they have the character of sandstones, are set down as pyrocrystalline when found in the company of talc and mica slates, while of clay slate, which is described as a pyrocrystalline rock, he says, "I should not regard it as an eruptive rock, and place it in this connection, were it not generally placed among the primary rocks, and were it not also quite common in proximity with veins in granite in North Carolina and other places."—p. 104. Good and sufficient reasons truly. Elsewhere we read of pyrogenic rocks, that "at one extreme of time the rocks formed were all crystallized, while at the other they all want it."—p. 62. There are no good grounds for distinguishing a third class of rocks distinct from those designated by Mr. Emmons as hydroplastic and pyroplastic. The former may be so far altered as to become crystalline, and even undergo fusion, so as to take the shape and position of pyroplastic rocks; indeed it would be difficult to prove that any of these latter rocks have any other origin than the fusion of subjacent hydroplastic strata.

The pyrocrystalline limestones are introduced to our notice by Mr. Emmons in the following language, *literatim:*

"The class of limestones under consideration, though they contain many minerals, yet as a rock it is not associated with any important ones except serpentine, and its congener rensselaerite. * * The circumstances under which this rock occurs in this country, warrants its recognition as a rock quite as distinct from all others as granite. It is by no means a metamorphic mass."—p. 57.

Having mentioned the limestones of Northern New York, and those of the southern counties of the same State, he proceeds to object to the view that they are Silurian strata altered by heat. In order to sustain his own notion of the igneous origin of crystalline limestones, Mr. Emmons confounds, perhaps ignorantly, the limestones of two different regions occurring under very unlike conditions. Those of Southern New York and the adjacent parts of New Jersey and Pennsylvania have been clearly shown by Rogers and by Mather to be of Silurian age, while the crystalline limestones of Northern New York belong to a formation older than the Potsdam sandstone. Mr. Hunt, of the Geological Survey of Canada, in a paper on the crystalline limestones of Canada and the Northern States, read before the American Association at Washington, in May last, and published in this Journal for September, has clearly pointed out the facts in these two cases, and has shown that the different limestones cannot for a moment be confounded; and that they have nothing in common, but the crystalline minerals which belong to the altered limestones of all geological ages. In Northern New York, as Mr. Hunt has shown, the presence of great stratified masses of a lime feldspar rock, having generally the composition of andesine or labradorite, and often mixed with hypersthene, characterizes the group to which the crystalline limestones belong, while there is nothing to represent these among the altered Trenton limestones of Southern New York.

Mr. Emmons brings forward many cases in illustration of his theory of the hypogene origin of these crystalline limestones, such as their occurrence in veins and intruded masses among the feldspathic and quartzose rocks of the region. That such cases exist is very true ; but any one who has intelligently studied them, will admit that the limestones are nevertheless interstratified with these felspathic and quartzose rocks, and that they may be traced for miles in the direction of the undulations, maintaining throughout, the same relation to the accompanying strata. We speak from personal observation. This is indeed so evident, that Mr. Emmons both in his Geological Report, and in the present work, finds no other means of describing the distribution of these limestones in New York, than to speak of them as beds, running N. E. and S. W. At the same time, Mr. Hunt, in the paper already referred to, observes that the limestone appears at some period to have been rendered almost liquid, and to have been subjected at the same time to great pressure, so that in many cases, it has flowed around and among the broken and often distorted fragments of the accompanying silicious strata, as if it had been an injected hypogene rock." (This Journal, [2], xviii, p. 194.)

The crystalline limestones of Pennsylvania, Virginia, and North Carolina are described by our author as "ranges belonging to the laminated and schistose rocks," yet he says, all these limestones must be regarded as belonging to the eruptive class, p. 83. According to him they resemble the limestones of the Hoosick range in Western Massachusetts, which are also pyrocrystalline, and are not to be confounded with the Vermont and Berkshire marbles, "which are of sedimentary origin and belong to the Taconic system." He then tells us that these two limestones are related to each other as granite and gneiss, as if he admitted the sedimentary origin of gneiss, which he has already classed with granite as pyrocrystalline. The distinction which he draws between the Washington and Pittsfield marbles is as baseless as the Taconic system to which he refers the latter. Both of these limestones belong to a single formation which may be traced with a continuous outcrop, from the exposures holding Trenton fossils near Missisquoi Bay, in Canada, through the marbles of Rutland, of Berkshire and of Westchester Co., N. Y., the alteration gradually increasing, until we reach Orange Co., New York, and Sussex Co., N. Jersey. Yet the sedimentary origin of these rocks is not more clearly marked, than is that of those of the Laurentian series, which, having been disturbed and rendered crystalline, are, along their whole outcrop in Canada and New York, covered by the unaltered and horizontal palæozoic strata of the New York system, the base of which is sometimes a conglomerate of these crystalline rocks. In the face of these facts Mr. Emmons would have us understand that the eruption of the crystalline limestones and serpentines was subsequent to the deposition of the Potsdam sandstone, which he asserts is vitrified in contact with the limestone. Again, speaking of the Adirondack Mountains west of Lake Champlain, which belong to the Laurentian series, he tells us that their elevation—

"Was probably subsequent to the consolidation of all Lower Silurian rocks. On Lake Champlain the evidences of movements of a much later date are fully established. * * These movements have taken place since the drift. * * It cannot be determined whether they extended to the central mass of mountains situated between Lake Champlain and the St. Lawrence. All that portion however of the hypersthene rock, which extends to the lake has been raised about 500 feet since the drift period."—p. 77.

The only evidence of recent elevation upon Lake Champlain, where all the palæozoic strata are undisturbed, is the existence of marine tertiary clays 500 feet above the present sea-level, and incredible as it may seem, Mr. Emmons has confounded the general elevation of the continent since the drift period, with the uplifting of the most ancient mountain system of America!

With regard to his vitrified Potsdam sandstone, the fact is simply this, that the limestones of the Laurentian series are generally associated with very quartzose strata, and often with pure quartz rock, which constitutes an important member of the series, and is constantly mistaken for the Potsdam sandstone by Emmons. We have seen the unaltered and horizontal beds of this sandstone reposing upon the upturned edges of the crystalline limestone which was interstratified with the vitrified quartz rock, having in some of the beds the character of a conglomerate. In connection with this, we may mention an error into which the author has fallen in his description of the Potsdam sandstone in his report on the Northern District of New York. He tells us that this rock appears at the Falls of Montmorenci in Canada, stained green with carbonate of copper, and resembling lithologically "the new red sandsone." At this locality the Trenton limestone with its characteristic fossils, reposes upon the gneissoid Laurentian rocks with the interposition of a thin layer of conglomerate sandstone the debris of the inferior strata. If this be Potsdam, the whole calciferous sandrock, with the Chazy, Birdseye and Black River limestones, are wanting.

Serpentine as we have already seen, is placed by Mr. Emmons among the pyrocrystalline rocks, yet he tells us that the evidence of its igneous origin "is less than that of primary limestone." "I have never seen it in narrow veins and dykes like greenstone, neither does it occur resting upon other rocks. It rather appears to have been protruded between other rocks, as at Middlefield, where one side of it is bounded by hornblende, and the other by mica slate."—p. 88. He elsewhere describes it as forming a belt along the eastern slope of the Alleganies extending from Canada to Georgia. Such modes of occurrence scarcely go to confirm the notion of its intrusive character, yet we are told that "the facts revealed by the relations of the associated rocks, support the view that serpentine is truly an eruptive rock, and belongs to the same class as granite and syenite," (p. 89—) "while it occurs so rarely among rocks of sedimentary origin, that its age, even approximately, is left undetermined." Who but Mr. Emmons will deny the sedimentary origin of the Green Mountain rocks?

We pass now to note some extraordinary statements with regard to the eruptive rocks on the Hudson River, known as the Palisades, which Mr. Emmons tells us—

"Are upon a north and south line of fracture, which extends northwardly through the valleys of the Hudson, Champlain, and St. Lawrence, in the range of Montreal and Quebec. The trap rarely appears on this line between the Highlands and head of the Champlain Valley. At this point trap begins to appear again, and with frequent repetitions down to Port Kent. From this place onward to Montreal, the disturbance of the rocks is much less; but at the latter place the phenomena justify us in regarding it as the centre of a highly disturbed district. It may be traced onward to Quebec. It does not necessarily follow that this belt was fractured for 400 miles north of the Highlands in New York, at the time the eruption of trap forming the Palisades took place, yet it probably was. This erupted mass ranges along this fractured belt, and if this belt extends to North Carolina, it is one of the longest lines of eruption east of the Rocky Mountains. Admitting the fact of the continuity of this long line of fracture, we are led to look for some cause which determined its extent and direction. We have found a part of this belt to be occupied by trap and greenstone, and to form a very striking feature in its geology; but upon other parts of the belt, though the rocks are fractured and very much disturbed, yet the eruptive rocks do not appear at the surface: for example, between the Highlands and the head of the valley of Champlain. This part of the belt, together with the more northerly part of it, between Montreal and Quebec, is upon a line of junction between two systems or formations, and the juncture or belt in proximity with it, is made up apparently of the thinnest masses of the system, and hence is a line of weakness. If this position is true then, and if it has been one of great tension, it explains the fact of the fracture and disturbance upon the line."—p. 111–112.

This extended line of fracture is purely imaginary. There is a great anticlinal which running along the Hudson and Champlain valleys, is prolonged into Canada, through that of the Yamaska River, and hence to Deschambault, thirty miles above Quebec. This anticlinal, as Mr. Logan has shown, divides the palæozoic rocks of Northeastern America into two great basins, and belongs to the series of undulations which have produced unconformity between the Champlain and Ontario divisions. Subsequent disturbances have affected the latter, as well as the Helderberg series, and it is upon the upturned edges of these different strata, that the liassic sandstones of the Connecticut and Hudson valleys (which our author calls triassic and permian,) repose in a nearly horizontal altitude, and are penetrated by outbursts of trap, having not even the most remote connection with the great northern anticlinal, which is of the palæozoic age. Montreal lies entirely out of the line, being some thirty miles to the northwest of this anticlinal, and in the midst of a broad area of almost horizontal rocks of the Champlain division, broken here and there by masses of trap, which with beds of volcanic ash, are interstratified with different members of the Champlain group. Yet we are told by Mr. Emmons, that "the phenomena justify us in regarding Montreal as the centre of a highly disturbed district."

The object of all this is to pave the way for his Taconic system, upon which, although it may be superfluous to most of our readers, we shall make a few remarks. The Taconic rocks, according to Emmons, are a series of fossiliferous sandstones, slates and limestones, reposing upon the western flank of the Green Mountains, and dipping beneath the rocks of the New-York system. The existence of such an inferior formation is however completely incompatible with the geological and geographical structure of the region; for while the Taconic rocks are supposed to play a very important part on the east side of Lake Champlain, they are entirely wanting a few miles to the west, on the opposite side of the lake, where the Potsdam sandstone reposes directly upon the crystalline rocks of the Laurentian series, which cannot for a moment be confounded either with the Taconic System or the gneissoid rocks of the Green mountains. Nor can any traces of such an inferior formation be found along the whole northern outcrop of the New York system of rocks, which are seen from Lake Huron to the Gulf of St. Lawrence to rest upon the Laurentian series, without the intervention of any other strata. Passing over the gneissoid rocks of the Green Mountains, we find reposing unconformably upon their eastern flank, formations which belong to the Ontario and Helderberg series, and north of the parallel of 45°, although much altered, they exhibit their characteristic fossils. The Lower and Upper Silurian formations are both traceable as far as the peninsula of Gaspé, forming a continuous outcrop of 700 miles, with a breadth of about 50 miles between the two, which is occupied by the crystalline rocks of the Green Mountains. Now if these crystalline strata be, as Mr. Emmons maintains, older even than the Taconic rocks, we are required by his theory to admit that both the Taconic and Lower Silurian strata are everywhere wanting along the southeastern side of these mountains. The simple solution of these difficulties, as long since shown by the Geological Survey of Canada, is this: the Green Mountains are the upper portions of the Champlain division in an altered condition, and the Taconic rocks as Mr. Hall many years ago made known, are none other than these same strata disturbed and partially altered. See also some remarks on the Taconic System, by H. D. Rogers, this Jour., 1844, xlvii, 151, and T. S. Hunt, Proceedings of the American Association for the Advancement of Science for 1850, p. 202.

The published results of the Canadian Survey show that the Green Mountain rocks as they escape from the limits of the altered district exhibit the characteristic fossils of the Hudson River group, while the white marbles of Rutland and Missisquoi, as already stated, afford the fossils of the Trenton limestone in their northern and southern prolongations. It has moreover been shown that the auriferous veins are not confined to the rocks of the Champlain division, but extend into the overlying slates. All these facts have been for years before the scientific public, and yet Mr. Emmons tells us, that the auriferous rocks are inferior to the Taconic System. He adds:

"There is no evidence that the Lower Silurian are metamorphic rocks which contain the gold of the country. * * * I entertain the opinion that we have no facts which sustain the doctrine that the rocks of the Blue Ridge are altered Hudson River sandstones and shales, and yet the Blue Ridge, which is auriferous, is identical with the Green mountain range."—p. 165.

Mr. Emmons conceives that the Taconic and Champlain rocks west of the Green Mountains are wedge-shaped masses, which in a breadth of a few miles are reduced from a thickness of several thousand feet to nothing, and it is along the overlapping edges of these extraordinary formations, that he fixes his "line of weakness," which corresponds to the imaginary line of fracture and disturbance. Comment upon this is unnecessary.

The detailed description of the hydroplastic rocks is not given, but we have, to compensate for this deprivation, some eighty pages devoted to mines and mining, which we can only say are worthy of the author. We pass over his crude notions about the theory of metallic veins, and the economics of mining, expressed in his usual style, and shall confine ourselves to pointing out some two or three errors. The iron ores of the Laurentian rocks are described as forming veins, while they in all cases form beds interstratified, with limestone and gneiss, and affected by all the undulations of the accompanying strata. The drawings given by the author, (pp. 140–150,) are sufficient to illustrate this, and to prove the incorrectness of his view. At p. 141 he attempts to explain the position of the iron by supposing that the strata have been folded since the formation of the veins.

The lead mines of Wisconsin and Iowa are said by Mr. Emmons to belong "to the Cliff limestone, the lower part of which is equivalent to the Niagara limestone of New York." This is an old error which was corrected some years ago by Mr. Hall, and it is now well known that the lead-bearing limestone of these regions rests upon the Trenton limestone and is overlaid by the Hudson River group. The lead mines of Missouri however occur in the Calciferous sandrock.

In his description of the copper mine of Bristol, Conn., we are told by Mr. Emmons that the ore is gray copper, with yellow sulphuret, and that the locality is remarkable for its fine crystals of gray copper. The crystals of *copper-glance* or vitreous copper ore from this mine are well known to mineralogists, but *gray copper*, (*fahlerz*) which Emmons confounds with this species, is a very rare ore in this country, and has never yet been found at Bristol. He also informs us that Chatham Co., N. C., affords veins of gray copper (copper-glance,) "which is probably an altered yellow sulphuret." But this is not the only instance where his mineralogy is at fault; on page 53, leucite is classed with the zeolites, although it is a feldspar and has no affinities with that class. Steatite is said by our author scarcely to differ from talc; but the only analysis given in the illustration of this similarity, is the following,—Silica 48·30, magnesia 26·65, oxyd of iron 2·00, alumina 6·18, and water 9·05, which is the composition of saponite; the true steatites contain upwards of 60 p. c. of silica, with but little water and no alumina.

Mr. Emmons's zoölogy is however still worse than his mineralogy. We quote a few samples from a glossary of scientific terms appended to his report on the Geological Survey of North Carolina, 1852.

"*Belemnite*—a fossil of a cylindrical form, tapering rapidly to a point, *and at one end or the other it has a conical cavity; it is the backbone of an extinct animal allied to the cuttle fish.*

"*Mammalia—animals which furnish glands for the secretion of milk.*

"*Mastodon—see mammoth.*

"*Mammoth*—an extinct thick-skinned animal allied to the elephant."

He thus confounds the two distinct genera *Mastodon* and *Elephas*. And these we are ashamed to say, are from the pen of a man, who is now, and has been for thirty years, Professor of Natural History in an American college.

Whatever else may be objected to our author, it must be conceded, that in endeavoring to enliven the technicalities of geology by excursions into other fields, he does not disdain to enrich his pages with gleanings from kindred sciences, and even to summon poetry and philosophy to compensate for his shortcomings in English grammar. We shall take the liberty of transcribing a few specimens for the gratification of our readers. In his preliminary sketch of the physical geography of North America, he thus discourses of the ocean. "The profound depths of the ocean are tenantless wastes, except for the dead who have here found resting places, where no wind or wave can move them, or bring up their sacred relics to light, and cast them once more upon a troubled shore."—p. 26. The belts of sand which skirt our Atlantic coast, "in time support a scanty vegetation and *admit of pasturage* for mules, horses, and sheep. The horses which run wild upon these semi-deserts belong to the pony breed; *but* they are tough and hardy," and our author naively adds, "They invariably refuse corn when first taken."—p. 12.

The moon "that luminary which shines with such silvery light and appears so plane and even" to Mr. Emmons, and which he calls "a smaller pattern of our earth" appears to have exercised a strong influence upon his imagination; he gives "a diagram from the Penny Cyclopedia," in order that the student "may *locate* the volcanic peaks," some of which he tells us "exceed one and a-half miles in height." We may remark that according to the accurate measurements of Beer and Mædler there are six of these mountains which are over 19,000 feet and more than twenty, over 15,000 feet in height. A little farther on, the moon's mass and density being given, we are told, "Hence a body weighing six pounds at the earth, would weigh one pound at the moon, *if each weight retained its terrestrial gravity!*"—p. 119.

In his report on North Carolina just quoted, he compares the cycles of the heavenly bodies with geological periods, and adds, "for us space is a unit, and it gives us a measure of time, so that time is space, and space is time, but geology cannot convert time into space, nor space into time." He then in the style of Mr. Chadband inquires "why geology gives us no unit" of time, and consoles himself with the reflection that "the inquiry is futile, and we can only say, that *it can have no final cause;* it can have no practical use."—p. 86.

As he draws to the close of the first part of his American Geology, and alludes to the progress of the science, our author speaks approvingly of the "inquiry after causes," and he tells us:

> "What is to be discouraged are the attempts to leap the wall at a single bound. We are to climb, and the steps are to be cut by labor. Proceeding in this way, even the essential nature of things may be opened before us. And who shall forbid inquiries into the essential nature of spirit? Step by step we climb the ascending pathway. Light gleams up in the distance. The essence of cause, the essence of God, may faintly illume the horizon of our prospects. It is the goal of man's hopes and aspirations."—p. 193.

This is sheer nonsense, or it would be blasphemy, of which we are willing to acquit the author. But we have copied enough of this, and our only object in calling attention to such a production has been to utter a protest, in which we are sure that every one who has the honor of his country or the advancement of science at heart, will unite, against Dr. Emmons and his book as exponents of American Geology.—x.

ART. XLI.—*Correspondence of M. Jerome Nicklès, dated, Paris, Dec.* 30, 1854.

ACADEMY OF SCIENCES.—*On the relations which exist between the chemical composition of bodies and their physical properties.*—The principal event of this month consists in the communication of the synthetic researches which have for a long time occupied M. Dumas, and which he has zealously pursued even when occupied with political and administrative duties as Member of the National Assembly and Minister of Agriculture and Commerce. No one is better fitted for success in this kind of study, a subject so well adapted to his generalizing mind, and which he first opened to the world when in 1822 he published in Blainville's *Journal de Physique* his paper "On the relations between the atomic weights and densities of bodies." At that time he announced the identity of atomic volume of certain analogous bodies which afterwards were recognised as isomorphous: thus he prepared the way since pursued by MM. Hermann, Kopp, Schröder and others, with so much distinction. He then entered upon his great researches on the densities of vapors, invented the process which bears his name, investigated the relations between the equivalents of volatile bodies and the densities of their vapors, studied the great questions of isomerism, polymerism and polymorphism, while at the same time he was perfecting the methods of investigation, and was also engaged with M. Liebig in bringing organic chemistry to the condition of a science.

Besides the communication which he made in 1851 to the British Association, an abstract of which has appeared in the American Journal of Science, M. Dumas has published nothing for some years. However, he has often spoken on the subject, in his course of lectures on Organic Chemistry at the Ecole de Médecine, and also since 1852, in his General course on Chemistry, at the Faculty of Sciences (Sorbonne): and when M. Wurtz, his successor in the Faculty of Medicine, made his beautiful discovery of ammoniacal homologues, and recognised that each of the 4 equivalents of hydrogen of $Az\,H_4$, could be replaced by a metal or by a carburetted hydrogen, M. Dumas immediately estimated the possible number of alkaloid analogues of ammonium which we may expect to obtain in this way, and placed it at 400,000 at least; and we now know that this number is far from an exaggeration.

What is the relation between the composition of these homologous alkaloids and their crystalline form or that of their compounds? This is a question which I have resolved in 1849* not only as concerns the homologous alkaloids, but homologous bodies in general. By giving to the word isomorphism the extension which Laurent gave it, I establish:—

1. The isomorphism of the crystallized ethers of the same kind.
2. The isomorphism of salts of the same kind and of the same homologous alkaloids.
3. The isomorphism of the anhydrous salts of the same base and of homologous acids.
4. The hemimorphism of these same salts differently hydrated.

* Recherches crystallographiques, par M. Nicklès, Comptes Rend. des Trav. Chem. de Laurent et Gerhardt, 1849.

I may take occasion to reproduce these facts which were at first strongly contested, although now admitted, and which a German chemist has recently brought out with some variations,* leaving it to be supposed that nothing had been done on the subject before.

Two communications have been made by M. Dumas on these physico-chemical questions. Not being able for want of room to speak of them with detail, I will restrict myself specially to that one which has not been published in the Comptes Rendus, but which M. Dumas presented orally to the Academy.

In order to compare, with advantage, the composition of bodies and their principal physical properties, M. Dumas employs a graphical method easily understood. He places, along the axis of abcissas, numerical values representing the atomic weights of bodies; and on the axis of the ordinates he writes the values corresponding to the physical property under comparison: when for example, he would treat of the atomic volumes of the alcohol series $C^nH^{n+2}O^2$, ordinates are drawn proportional to their volumes, and it is at once seen that all these ordinates terminate in the same straight line making a certain angle with the abcissas; in producing this line towards the axis of the abcissas, it passes near the summit of the ordinate which corresponds to water, HO, the point of departure for the series.

The acids $C^nH^nO^4$; corresponding, as is known, to the series of so called alcohols, afford the same result; all the ordinates of these acids have their extremities in this same straight line parallel to that of the alcohols to which they are related, and the prolongation of the line for the acids ends at the summit of the ordinate corresponding to the atomic volume of the binoxyd of hydrogen or oxygenated water HO^2.

As to the ethers of different acids and alcohols: the lines for the ethers of the same base but of different acids are parallel to the lines of the alcohols and acids; but for ethers of the same acids and of different bases, they are parallel to one another, but not to those of the alcohol and acids. The line of the nitric ethers meets the place of hydrated nitric acid; that of the sulphuric ethers passes by the point representing hydrated sulphuric acid: the summit of the ordinate corresponding to liquid sulphuretted hydrogen is in the line of mercapton and its homologues. In fine, then, on producing the line of the ethers of the same acid, you always meet the point of the hydracid or hydrated acid corresponding.

The line of the aldehyds is parallel to that of the alcohols; it is however a little less elevated. The acids and the alcohols of the same series are united by lines almost parallel to the axis of the abscissas. The lines which unite the places of the compound ethers, the simple ethers, and the anhydrous acids, are straight, as well as those which unite together the alcohols and the hydrated acids; but the ether and its alcohol, the compound ether and anhydrous acid, are sinuous lines and very irregular (tres accidentées). The above are the principal facts flowing from the researches which M. Dumas presented in an eloquent manner before a most distinguished and attentive audience.

Limits of the vaporization of Mercury.—Till now it has been admitted with Faraday that the vaporization of mercury is very lim-

* Annalen der Chem. u. Pharm. Aug., 1854.

ited; that at 20° C. the mercurial vapor may reach a height of one decimeter, and at a lower temperature to 0° C., it does not exceed two centimeters. Faraday employed in his experiments a plate of gold placed at the requisite height. M. Brame, Professor of Chemistry at Tours, has found on his trials, that the vapor passes much beyond these limits. He used a reagent more sensitive than gold, viz., sulphur deposited in a vesicular state on a plate of glass, which becomes brown under the influence of mercurial vapor. In the vaults of the Paris Observatory where the temperature is uniform, this reaction took place at a height of 1·20 metres in the space of twenty days; and by prolonging the experiment he was enabled to condense on the surface a ponderable quantity of mercury. It was the same with mercurial ointment, silver amalgam, tin amalgam, &c. From these experiments and others tending towards the same end, M. Brame concludes that the vapor of mercury is subjected to the ordinary law for the mixture of gases and vapors.

Assimilation of Nitrogen by Plants.—This subject is always under discussion. M. Boussingault persists in denying more strongly than ever, that plants can assimilate nitrogen directly from the atmosphere. His experiments have always been made on limited portions of air, while M. Ville, on his side, has constantly operated in the free air and perseveringly sustains the fixation of nitrogen. The following explanation offered by an agriculturist, M. Roy, appears to harmonize these discordant results. He admits that nitrogen from the air is not absorbed by the leaves, but that when dissolved in water, it is taken up by the roots. But a plant in an enclosed portion of atmosphere, which is developed wholly in this condition, does not transpire water by the leaves; and it hence must absorb by the roots only a very limited quanity of water and consequently an inappreciable quantity of nitrogen; such is the case in the experiments of Boussingault. On the contrary a plant endowed with great power of transpiration, as wheat, placed in the apparatus of M. Ville, absorbs as much more water as the transpiration is more active from the renewal of the air. The quantity of nitrogen which is then taken up by the water into the interior of the plant and assimilated, is sufficient to be sensible in analysis.

Action of some animal fluids on the fats.—It is known that M. Cl. Bernard attributes to the pancreas, the property of emulsionating fatty substances. M. Blondlot, Professor at the School of Medicine at Nancy, finds that this property does not belong exclusively to the pancreas; the chyme possesses it to the same degree. M. Longet now announces that the seminal fluid possesses this property in a much higher degree, and that under a temperature of 35° to 40° C., during 14 to 16 hours, fat is decomposed into fatty acids and glycerine. Before subjection to heat, the emulsion has an alkaline reaction, and after this treatment it is acid.

Calculating Machine.—This machine is the invention of M. Thomas, of Colmar (Haut-Rhin). It was registered at the Patent Office in 1820; and ever since then he has been perfecting it. His efforts have been appreciated, and the machine has taken a prize from the "Société d'Encouragement" in 1849, and at the World's Exhibition at London. It was recently reported upon at the Academy of Sciences by a commission consisting of MM. Cauchy, Piobert and Matthieu. A similar honor has been conferred upon the author by the Academy of Sciences at Madrid, yet with a singular restriction: the Spanish Academy feared that if brought into use, it would be a damage to society by creating a distaste in those who would use it to exercising their minds in the study of numbers and their combinations.

Pascal, who was the first to conceive of an arithmometer, though without the ability to realize his conceptions, was of a different opinion, and so have been the many scientific and practical men who have highly applauded all attempts of this kind. The arithmometer of M. Thomas will be at the World's Exhibition of 1855 at Paris. The apparatus is two metres long, and is constructed for 30 numbers: it gives the products of 15 numbers by 15 even to

999, 999, 999, 999, 999, 999, 999, 999, 999, 999.

It can consequently express an amount exceeding the number of grains of wheat in the whole world. When there is written on the squares the large number

999, 999, 999, 999, 999,

and upon the first slide ("coulisse") a unit is written, by a single turn of the crank, there appears in an instant

1,000, 000, 000, 000, 000,

a result of a series of simultaneous changes, which are performed as by enchantment.

A description of this beautiful piece of apparatus may be found in all its details in the Comptes Rendus for Dec. 11, 1854; it is by the Commission, by whom the arithmometer was examined and used for several months to their entire satisfaction.

Artillery in the 15th Century.—A learned historian, M. Dureau de la Malle has discovered in the Public Library of Rennes, (Dep. of l'Ille et Villaine,) a manuscript illustrated with drawings representing the arms used in war in the 15th century. It is a French translation of a celebrated work written in 1473 and entitled "*Gouvernement des Rois*, par Gilles Colonna, Ægidius Romæ, fundatissimus Doctor," to whom Philip "Le Hardi" King of France entrusted the education of his son Philip "Le Bel." It contained originally 10 designs which are attributed to Jean de Bruges, "Grand-maître" of the artillery of the Duke of Bourgogne Philip "Le Bon." These designs are now but seven in number; but they are sufficient to prove that cannon, howitzers, hollow projectiles, bombs, were not a Flemish invention, and that they were not first used in the battle of Crécy; that these agents of destruction were perfectly well known at the end of the 14th century and the commencement of the 15th. Even the Paixhan guns were not a recent invention, though reintroduced in modern times.

Gilles Colonna taught his young student to make a breach into the most formidable ramparts in 14 to 20 days.

Zoological Society for Acclimation and Domestication.—A year has hardly passed, and this Society* has already extended itself enormously and engaged the attention of all men of science and of almost

* See this Journal, May, 1844.

all European governments. The monthly Bulletin is full of results obtained by its influence and efforts. We owe to it partly the introduction of the *Bombyx Cynthia*, the silkworm which feeds on the Ricinus, as already mentioned ;* also the introduction of the *Yak*, a ruminant of Thibet which is now succeeding well in the Jura mountains where they are in a state nearly of liberty, under the superintendence of two members of the Society residing in those regions. These animals have already reproduced ; they afford milk and butter of good quality, and their hide is useful for various purposes. M. Dollfus, President of the Industrial Society of Mulhouse, and M. Schlumberger, Spinner, have made yarn from the wool of the Yaks which this Society had sent them, and they say that the manufacturers of carpets would obtain beautiful results from the product, it having high lustre and uniting the softness and elasticity of wool with the strength of the stoutest hair. According to a report of M. Duvernoy, Professor of Zoology at the Muséum d'Histoire Naturelle and at the Collège de France, the Thibetans make out of the wool of the yak a cloth which sheds water. This animal has been domesticated in Asia, and there is every prospect of success here. It is important to remember that the domestication of the merinoes, alpaca and lama was slowly accomplished ; that of the merino, conceived by Colbert, took a century ; that of the lama and alpaca, undertaken by Buffon, Is. Geoffroy St. Hilaire and others, is not yet completely realized. The Society of Acclimation has it in hand, and with its abundant means and extended resources, the experiment will be faithfully tried.

Besides the above, the Society, on the report of Dr. Richard, Vice President, has undertaken to promote the multiplication and training of the *Hemione* (a species of the genus Horse), which is already domesticated at the Muséum d'Histoire Naturelle, under the care of I. G. St. Hilaire, President of the Society. It has been trained without trouble for the saddle and traces ; it carries its rider without "mauvaise volonté." The female is easily managed. The animal is very intelligent, but also very sensitive, and it is necessary to treat him with gentleness, as harshness renders him restive and ugly. Dr. Richard has made the domestication of animals his study through life : his specialty is Zootechny of the mammifers, and his experience is of the highest value in all these questions of acclimation and domestication.

Silkworms.—Since the muscardine has made so great ravages among the mulberry silkworm, there has been an attempt to introduce other kinds of silkworms. I have already spoken of the Bombyx of the Ricinus. It is now proposed to acclimate three American species of Bombyx ; the *Cecropia* whose larves feed on leaves of the willow and may be fed also on the plum ; the *Luna*, an elegant species of a green color, which lives on the Liquidambar, and which will also eat the leaves of different species of walnut ; the *Polyphemus*, a large *Attacus*, of a brownish gray color, which feeds on the apple, oak, beech, &c. These three species are abundant in the woods of Louisiana, Georgia and South Carolina. Their silk is of inferior quality ; but it costs so little to obtain it, that the acclimation of the species is regarded as desirable on the score of economy.

* This Journal, January, 1852.

Objections have been made to the introduction of silkworms affording silk of an inferior quality. It is said that the ordinary silkworm is sufficient and that its production may be easily increased by extending its culture, so that France would not have to pay out to foreigners several millions of francs for raw silk for its manufactures ; and also that the Indian silkworm is better. This is like objecting to the introduction of the ass because the horse is a superior animal.

The great defender of both indigenous and exotic silkworms, M. Guérin Mèneville, well known by his numerous works in Natural History, has published a series of excellent papers on the subject in the Bulletin of the Zoological Society of Acclimation. He has founded, in connection with E. Roberts, at St. Tulle (Dep. of the Basses-Alpes) a Sericicole Institute (Institut Séricicole) in which they give gratuitously a theoretical and practical course on the silk industry. There are students there from different parts of France, besides some from foreign countries ; they assist in the labors of acclimation and amelioration of races which M. Guérin Mèneville has undertaken, this savant giving, with rare disinterestedness, six months of each year to these labors.

Anesthesis of Bees.—Apiculturists often find it desirable to stupefy bees, when, for instance, there are two feeble swarms and it is best to kill the queen of one. In Brittany, as well as in Alsace, the smoke of a common puffball, *Lycoperdon cryptus Lupi*, has been employed from time immemorial. In the Dict. d'Hist. Nat. of D'Orbigny, it is reported that in Southern Russia the *Lycoperdon horrendum* and the *Endoneuron suberosum* are used to intoxicate the bees in order to get their honey. Dr. de Beauvoys has taken up this subject, and has found that the best species for the purpose is the *Lycoperdon giganteum*. In using it, a piece of the Lycoperdon is put on burning charcoal contained in a chafing dish and covered with a funnel of stoneware, and the smoke is directed from it into the suspended hive : a cloth laid on the ground receives the bees as they fall. The experiments have been repeated before the Zoological Society, in which the stupefaction of the bees continued for half an hour.

Pisciculture.—This important subject has occupied much the Society of Acclimation. A method has now been ascertained by which we may know the maturity of the eggs of certain fishes, a method which has been arrived at through the researches of MM. Valenciennes and Frémy on the eggs of osseous fishes. These investigators have found that the eggs, while adhering to the ovarian lamellæ, give with water an abundant precipitate of a substance named by them *Ichtuline ;* while the mature egg affords no ichtuline : whence the eggs of certain fishes are ready for fecundation when they give no precipitate with distilled water. In this trial with the Cyprinoids, for example, an egg is taken and broken upon a plate of glass, and a drop of pure water added : if the liquid is not clear the egg is not mature.

Production of Alcohol.—The question bearing on the cheap production of alcohol has not made much progress since my last communication. New projects and new processes have been sent to the *Société d'Encouragement* without appearing to resolve the problem. Asphodel, in this connection, may look forward to a fine future. According to Dumas, the quantity of bulbs of asphodel in Algeria is enormous, they cover a space 20 leagues square and are so crowded that clearing them out is a great labor.

General Vaillant, who commands one of the military divisions in French Algeria, states that the pulp proceeding from the extraction of the alcohol from asphodel may be used as food for hogs, who eat it without hesitation and with advantage. In the month of May, June, July, and August, the proportion of the fermentable principle reaches even 12 p. c., nearly the maximum of that of cane sugar, and almost double that of beet sugar.

M. Dumas also calls attention to another plant more abundant still in Algeria, the *Scilla maritima*, whose large and dry bulbs are so crowded in the soil that no space is left between. According to M. Fée, Professor of Botany in the Faculty of Medicine of Strasburg, the Scilla affords more than 30 p. c. of saccharine matter. It is however important to remark that it contains also a bitter principle which may injure the alcohol.

Photographic news.—A number of Photographers are attached to the army in the east and share in the fatigues of the Crimean campaign. Four hundred photographic proofs have already been sent by them to Paris. They present the facts respecting the land and sea forces in all their aspects and circumstances, with astonishing precision.

One of the most surprising operations in Photography is the reproduction of flowers, leaves and branches. At a recent meeting of the Academy of Sciences, amateurs have been agreeably surprised with the exhibition of an album containing more than one hundred photographic proofs of flowers, remarkable for the harmony and perfection of the work. The author is a protestant pastor, M. Braun, of Doznach near Mulhouse (Haut-Rhin). He proposes to form a collection of studies, for artists who employ flowers as a means of decoration for painting cloth or paper, a manufacture for which the Haut-Rhin is distinguished. He also engages to group branches and flowers in a manner to produce effects highly interesting in an artistic point of view. Unfortunately M. Braun has not made known his secrets: we have heard accomplished photographers say that the processes actually known are altogether insufficient for attaining the results which he claims.

Photographic proofs of another kind have been exhibited at the same Academic session by MM. Bisson brothers, Parisian photographers, for a long time well known. They are views of the Louvre, of a size which exceeds all that has been hitherto seen. They had before exhibited some fine views; but they were far inferior to these, which are 80 centimeters (30 inches) high and 60 broad, and as perfect at the border as at the centre. The negatives on collodion were taken with objectives having an aperture of 5 inches, and 2 meters focal distance, from the shop of Lerebours and Secrétan. The plate was exposed about 20 minutes.

Œuvres de François Arago, tome ii, Des Notices Biographiques. *Paris.* Chez Gide et Baudry.—This new volume contains the Eulogies of Ampère, Condorcet, Bailly, Monge, and Poisson, which were read at different times at the sessions of the Institute of France, and are almost all unpublished.

Astronomie Populaire, par Fr. Arago, tome i. *Paris.* Chez Gide et Baudry.—The author, in this volume, describes with his usual clearness the instruments used by astronomers. Apparatus the most delicate and the most complicated are treated of with so much simplicity that they become intelligible to persons least familiarized with physics.

Leçons Elémentaire de Chimie, par M. Malaguti, Prof. de Chim. à la Faculté des Sciences de Rennes. 2 vols. in 12 mo, pp. 736–740. *Paris.* Chez Dezobry et Magdeleine.—These *Lessons* are arranged in the form of a course. In preparing them the author had his audience under his eyes. They are written with a precision and perspicuity which have given great success to the work. M. Malaguti has bestowed upon it the same care as on his fine discoveries in organic chemistry.

Dictionnaire raisonné d'Agriculture et d'Economie du Bétail, suivant les principes des Sciences appliquées, par le Dr. Richard (du Cantal) Vice President of the Zoological Society of Acclimation, &c. 2 vols. in 8vo. *Paris.* Chez Auguste Goin.—Definitions of technical terms; rural economy; multiplication, hygiene, crossing, pairing, raising, acclimation, of domestic animals; study of good and bad conformation; choice of kinds or types for reproducing; their influence on the amelioration of races; elements of the veterinary art, of physics, of agricultural entomology, of grazing, botany, &c. &c.; such are some of the subjects, treated by Dr. Richard, with his recognised ability. This work of the Vice President of the Zoological Society of Acclimation has been received with acclamation by its distinguished members.

Correspondence of M. Nicklès, dated, Paris, March 1, 1855.

Obituary notice of Melloni.—The philosopher Melloni, whose death we announced in November, 1854, was born near the commencement of the century at Parma, where he began his studies. His sagacious and observing mind was soon apparent to his parents and teachers. The phenomena of the radiation of heat even thus early interested him and he was not slow to suspect the analogy between the radiation of heat and of light. More fortunate than Laurent and other promising youths, the young Macedoine Melloni had at least the satisfaction of seeing himself understood by those who had charge of his education. They encouraged his studious habits instead of endeavoring to divert him, and when in 1824 the Chair of Physics at Parma became vacant, Melloni was appointed to it although he had not then published any of his researches.

Completely destitute of instruments, the young professor devoted his first efforts to contriving them. Nobili had just then constructed his thermoscope. Melloni soon brought it to perfection, and Nobili was so pleased with the result that he proffered him his friendship. A note which Nobili inserted in the "Bibliothèque Universelle" of Geneva is a token of the interest which that philosopher felt in the researches of Melloni. This was almost his only labor at Parma where he remained till 1831; a considerable change then took place in his position which stimulated his activity and from that time he began to publish the beautiful discoveries which established his fame.

The political events which overturned Italy during 1831 were the cause of this change. Melloni was one of the leaders of the Carbonari. Unfortunate and proscribed, he took refuge in France with his thermoscope. As he was already well known to the French savants they were not slow in giving him a position and thus provided him with the means of continuing his studies. He was appointed to the chair of Physics in the College of Dole (in the Jura) a little village unfortunately destitute of scientific resources. Not wishing to remain long at such a distance from all scientific centres, he took his dismission and returned to Geneva long renowned for Saussure, DeCandolle, De la Rive and Prevost. Now at length his intellectual wants were satisfied. De la Rive put at his disposal his scientific apparatus, and with these conveniences he prepared his first memoir upon the radiation of heat, soon followed by many others, for which, on the recommendation of Faraday he obtained the Rumford Medal which had been given some years before to Malus and Fresnel. At the same time M. Biot made an able report to the French Academy upon all the labors of Melloni, from his thermo-multiplier which was so sensitive as to be affected by the heat of the human body at a distance of 50 feet, down to the heterogeneity of the calorific spectrum, a discourse which led De la Rive to call Melloni "the Newton of heat." During this time, the Italian philosopher was attentively examining the different sources of heat: he repeated the experiments of Davy upon the proper heat of insects, and he observed anew that the phosphorescent bodies give certain indication of sensible heat. He also studied the moon with reference to its radiation of heat and was a long time without obtaining satisfactory results. However after a time he succeeded, having used a lens a metre in diameter, and taking many precautions.

So many remarkable labors called toward him the attention of the Italian government. He was summoned to Naples as Professor of Physics, and charged with meteorological observations upon Vesuvius. He remained in this position until quite recently and was removed from it at a time when he least expected it. Without taking into the account the services which he had rendered to science, the Italian government heeding only its own fears or its resentments, deprived him of his post and rendered it impossible for him to continue his researches. He retired to a farm which he owned in the vicinity of Naples and there occupied himself with some investigations in electricity, until his death, which occurred on the 7th of August, 1854, brought them unfinished to a close. A treatise upon the calorific spectrum, entitled, "La Thermochrose," was found among his papers and published by his friends. Melloni was a corresponding member of the French Institute, and also of other scientific bodies.

Death of M. Braconnot.—The discoverer of xyloidine, pyrogallic acid, equisetic acid, leucine, populine, etc., the author of the transformation of wood into sugar, the patient analyst, who for half a century has continued his labors upon the proximate principles, died at an advanced age at Nancy in the department of Meurthe on the 13th Jan., 1855, where he was established and where nearly all his labors had been performed. In another communication, I will give some biographical account of this celebrated chemist.

Death of Joseph Remy.—We have often brought before our readers the poor fisherman of the Vosges mountains who without instruction, without scientific education, was a discoverer in the domain of natural history, and gave to humanity a new branch of useful industry well named, pisciculture. He died as he lived, poor and modest, having hardly had opportunity to enjoy the pension allotted to him by government. He expired at 51 years of age in his native village *la Bresse* (department of Vosges). We have, during his life time, given a short account of his career, which may be found in the volumes of this Journal of the two years past. He left a wife and six children, the oldest of whom, a young man of 30, shows talents similar to his father's, if we may judge from his fulfillment of the charge committed to him by the minister of Agriculture for repeopling the Loire.

Monument to Arago.—The subscriptions for the erection of a monument to Arago have amounted to a sum sufficient to carry out the plan proposed. A sarcophagus of a simple and severe model, ornamented with wreaths of laurel, and having inscribed upon it the titles of the principal works of Arago, will support his statue cast in bronze. This recumbent statue will be covered by a shroud, the head inclined, the pen falling from his dying hand, as it wandered over the celestial sphere. The execution of this monument has been intrusted to a celebrated sculptor, David Angers, and its completion is expected by the last of May. (*To be continued.*)

Extract from a letter from T. S. Hunt to J. D. Dana, dated Montreal, Canada, March 12, 1855.

On the Equivalent of some species.—The crystals of the compound of grape-sugar and common salt, which you have found to be rhombohedral, closely approximating to $-2R$ of calcite*, gave me by analysis 13·31 p. c. of NaCl closely agreeing with the formula of Erdmann and Lehmann, $C_{24}H_{24}O_{24}$, NaCl, H_2O_2, which requires 13·40 p. c. The density of this substance was determined with great care in oil of turpentine, and gave for small well formed crystals the numbers 1·561 and 1·575; two other trials with crystals half an inch in diameter, gave each 1·558. The mean of these four determinations is 1·563 (water being 1·000), and gives for the above formula with an equivalent weight of 436·5, a volume of 279·25, which doubled is 558·5. I had previously, as you know, fixed the volume of calcite and the species homœomorphous with it, at between 555·0 and 564·0, and the present determination seems to confirm the correctness of my view. It is worth while to compare the volume of this compound with those of milk-sugar and cane-sugar, both prismatic species, whose volumes, corresponding like the above to C_{48}, etc., are respectively 464 and 430, according to the determinations of Playfair and Joule. Correct observations upon the crystallization and density of grape-sugar are still required.

The crystals of codeine which you find to approach brookite in form, and which may likewise be compared with Barytes†, gave me in three

*. The crystals are little shorter than broad and present the faces of an acute rhombohedron with the terminal truncating plane O, this last convex. The angle of the rhombohedron, over a lateral edge is 101° 40′, giving for the angle over the terminal edge 78° 20′. The angle of $-2R$ in calcite is 78° 51′.—J. D. D.

† The angles obtained by the writer for codeine using reflected light with the reflecting goniometer are $I:I = 99° 48'$, $i\bar{2}:i\bar{2} = 134° 20'$, $1\bar{i}:1\bar{i} = 93° 20'$. Miller obtained for the corresponding angles 100° 46′, 134° 50′ and 92° 20′; and Kopp found for the first and last 101° 30′ and 92° 30′. If Miller's 134° 50′ is right, then his 100° 46′ would be by calculation, 100° 30′. The corresponding angles in Brookite are 99° 50′ (to 100° 50′), 134° 22′ and 93° 16′. These are very near the corresponding angles of Barytes, if $1\bar{i}$ be taken as $\frac{2}{3}\bar{i}$.—J. D. D.

determinations of density, with large crystals, the numbers 1·302, 1·297, and 1·300 (water being 1·000), giving a mean of 1·300, which, with the formula fixed by Anderson, $C_{36}H_{21}NO_6+H_2O_2=317$, gives a volume of 244. The density was determined in distilled water, and I convinced myself that the loss by the slight solubility of codeine in this liquid, produced no sensible error.

I have made two determinations of the density of transparent cleavable rock salt, in oil of turpentine, and have obtained the numbers 2·137 and 2·134, (water being 1·000,) which approach very nearly to that of Kopp, 2·15. Taking as the mean 2·135, we have for the volume 10NaCl the number 172, corresponding to the volume of alum, 274. (See this Journal [2], vol. xvi, p. 206.)

On the so-called Talcose Slates of the Green Mountains.—Besides the beds of steatite and chlorite slate among the altered Hudson River rocks, there is a great amount of reddish and greenish glossy unctuous slates, which disintegrate very much by the action of the weather, and have hitherto been known by the name of talcose slates. It was however evident that these were formed by the alteration of ordinary clay slates, and I have found by analysis that they contain little or no magnesia, but are essentially silicates of alumina, belonging to the class of minerals represented by pyrophyllite and pholerite, which are aluminous talcs. The *nacrite* of Thompson from Brunswick, Me., is probably allied to the former, and his *talcite* from Wicklow, Ireland, to the latter species. In the crevices of a sandstone associated with the above described slates on the Chaudière river, I have obtained a beautiful white mineral in minute pearly scales, whose analysis has afforded me the composition of pholerite. I shall send you soon my detailed results; meanwhile, to avoid the perpetuation of an error, I would suggest for these unctuous aluminous schists the name of *nacreous* or *nacrite slates.*

On a newly discovered Meteoric Iron.—A large mass of native iron was found last autumn upon the surface of the earth in the township of Madoc, C. W.; it has since been procured by Mr. Logan, the director of the Geological Survey, in the collection of which it has been placed. The mass is rudely rectangular and flattened, but very irregular in shape; its surface is deeply marked by rounded depressions which are lined with a film of oxyd. It closely resembles in appearance the Lockport (N. Y.) iron, with which it seems to agree in composition; a single analysis gave me 6·35 per cent of nickel, in which no cobalt was detected. The iron is very soft and malleable, and from a trial with a small fragment, exhibits a coarsely crystalline structure; the weight of the mass is 370 pounds. We purpose to have it cut, and I shall then be able to make a more complete examination of the iron.

On some Ores of Nickel from Lake Superior.—Some specimens from Michipicoten Island, Lake Superior, furnished me by my friend and pupil, Mr. Charles Bonner, have been found to consist of *nickeline* $AsNi_2$, and *domeykite* $AsCu_6$. The ore was mistaken for the first named species, but is intermixed with a tin-white mineral, often tarnished, which appears to be the arseniuret of copper, since the varying results of several analyses, correspond to different mixtures of the two species. Associated with these is an amorphous earthy mineral with a conchoidal fracture; its hardness is not greater than 2, and it polishes under the nail, is translucent on the edges, and falls to pieces when placed in water. Its color is yellowish-green to olive-green. This material is the gangue of native silver and native copper, and is represented as occurring in considerable quantities. It is a hydrous silicate of nickel-oxyd, allied to the nickel-gymnite of Genth, but differing from it in containing less magnesia and some alumina. One of two concordant analyses, executed by Mr. Bonner under my direction, gave, Silica 33·60, oxyd of nickel with a little cobalt 30·40, magnesia 3·55, lime 4·09, alumina 8·40, peroxyd of iron 2·25, water 17·10=99·39.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the specific volumes of fluid compounds.*—Kopp has resumed his investigation of this very interesting subject and has communicated some new results of much theoretical value. By specific volumes the author understands the relative spaces occupied by equivalent weights of different substances and they are obtained by dividing the equivalents by the corresponding densities. If the equivalents are expressed in grammes the specific volumes will be expressed in cubic centimeters. To institute however a proper comparison between the specific volumes of liquids, the author long since showed that it was necessary to determine these volumes either at the boiling points, or at temperatures equally distant from these and for which the tension of the vapors is the same. Thus the specific volume of alcohol at its boiling point is the sum of the specific volumes of water and ether at their boiling points. Kopp's own elaborate investigations of the densities of bodies at different temperatures, together with those of Pierre on the same subject, have furnished materials for the present instructive comparison. The author in the first place, by the comparison of the specific volumes of a number of ethers, as well as of several alcohols and acids, demonstrates the correctness of the proposition formerly advanced by him, that an equal difference of specific volume corresponds to an equal difference of constitution. Thus for a difference of constitution of C_2H_2 the difference of specific volume is about 22. In like manner it appears that when an organic acid passes into the corresponding methyl or ethyl ether, a corresponding change of volume of 22 is produced, thus the difference between

Formic acid and formate of methyl is	21·3
Acetic acid and acetate of methyl is	20·4
Butyric acid and butyrate of methyl is	19·5
Formic acid and formate of ethyl is	21·5
Acetic acid and acetate of ethyl is	22·0
Butyric acid and butyrate of ethyl is	21·5

The author's former assumption that fluids of the same empirical formula but different rational constitution have equal specific volumes at their boiling points, is confirmed by the following numbers, which at the same time show that—as also formerly advanced by him—equivalent weights of oxygen and hydrogen may replace each other in fluid compounds without a sensible change of volume.

Wood-spirit $C_2H_4O_2$	42·3	Acetic acid $C_4H_4O_4$	63·5
Formic acid $C_2H_2O_4$	41·8	Formate of methyl $C_4H_4O_4$	63·1
Formate of ethyl $C_6H_6O_4$	84·7	Butyric acid $C_8H_8O_4$	106.7
Acetate of methyl "	83·9	Acetate of ethyl $C_8H_8O_4$	107·4
Amylic alcohol $C_{10}H_{12}O_2$	123·3	Anhyd. acetic acid $C_8H_6O_6$	109·9
Buty'e of methyl $C_{10}H_{10}O_4$	126·3	Buty'te of ethyl $C_{12}H_{12}O_4$	149·7
Alcohol $C_4H_6O_2$	62·2	Valerate of methyl "	149·6

The comparison of the specific volumes taken at temperatures equidistant from the boiling points leads to the same results though with less close approximation, while the specific volumes taken at 0° shew but little connection with each other. The author next investigates the questions whether the specific volume of the same elements is to be considered as equal in all liquids at corresponding temperatures and whether the specific volume of a fluid can be expressed simply by the sum of the specific volumes of its constituents, in the case of a compound of carbon, hydrogen and oxygen, for example, by a formula like $xc+yh+zo$ where c, h and o represent the specific volumes of carbon, hydrogen and oxygen in such compounds at their boiling points. According to this formula the specific volume of a compound $C_xH_yO_z$ ought to be precisely half of that of a compound represented by $C_{2x}H_{2y}O_{2z}$, and the specific volume of a compound should be equal to the sum of the specific volumes of two others when the formula of the first is the sum of the formulas of the other two. This however proves not to be the case, thus twice the specific volume of aldehyd $C_4H_4O_2=113·9$ while the specific volume of acetate of ethyl $C_8H_8O_4=107·4$. In like manner $C_4H_4O_2+C_6H_6O_2=56·9+77·4=134·3$, while $C_{10}H_{10}O_4=126·3$. Hence the author infers that in comparing the specific volumes of liquids, only the spaces filled by the true equivalents and not multiples of these are to be considered. The want of coincidence in the specific volumes of aldehyd and ether is explained at once if we consider the formula of ether to be $C_8H_{10}O_2$ as Gerhardt long since proposed. The author leaves it for the present undecided whether it is possible to determine the specific volumes of carbon, hydrogen and oxygen. Although many compounds give the specific volume of carbon 6·3 about, others give somewhat different values; it may be that the data for these latter determinations are inaccurate, and that in all, as certainly in the majority of cases, the specific volume of a compound is simply expressed by the sum of the specific volumes of its constituents and that at corresponding temperatures the same element has the same spec. vol. in all fluid compounds. The author is engaged in the experimental solution of this problem. The specific volumes of fluid compounds may be brought under one point of view by adopting the theory of Gerhardt that water has the formula H_2O_2 ($H=1$, $O=8$) and that the ethers, alcohols and unibasic acids may be considered as derived from water by the replacement of one or both the equivalents of hydrogen by other radicals. Thus when in water (S. V$=18·8$ at 100° C.) an equivalentof hydrogen is replaced by an equivalent of ethyl there is an increase of volume of 45 since the specific volume of alcohol is 62·8. When the second equivalent of hydrogen is replaced by one of ethyl the same change of volume occurs and we have 106·2 for the specific volume of ether which agrees with experiment. The same result is obtained for the acids and aldehyds which may be considered as derived from water by the total or partial replacement of the hydrogen by radicals like acetoxyl $C_4H_3O_2$ and acetyl C_4H_3. If from the specific volume of acetic acid $\left.\begin{matrix}C_4H_3O_2\\H\end{matrix}\right\}O_2=63{\cdot}0$ we subtract that of aldehyd $\left.\begin{matrix}C_4H_3O_2\\H\end{matrix}\right\}=56{\cdot}8$ we obtain 6·2 as the specific volume of the 2 atoms of oxygen which occupy the space of the oxygen in water. The two atoms of hydrogen in water then occupy the space $=18{\cdot}8-6{\cdot}2=12{\cdot}6$ and each atom of hydrogen consequently the space 6·3. From these considerations taken in connection with the results above stated the author makes the following representation of the part played by each element in forming the following compounds.

			S. V. Calculated.	S. V. Observed.
Water,	$\left.\begin{matrix}H\\H\end{matrix}\right\}O_2$	$\left.\begin{matrix}6{\cdot}3\\6{\cdot}3\end{matrix}\right\}6{\cdot}2=$	18·8	18·8
Wood-spirit,	$\left.\begin{matrix}C_2H_3\\H\end{matrix}\right\}O_2$	$\left.\begin{matrix}6{\cdot}3\\28{\cdot}3\end{matrix}\right\}6{\cdot}2=$	40·8	42·3
Formic acid,	$\left.\begin{matrix}C_2HO_2\\H\end{matrix}\right\}O_2$	$\left.\begin{matrix}28{\cdot}3\\6{\cdot}3\end{matrix}\right\}6{\cdot}2=$	40·8	41·8
Alcohol,	$\left.\begin{matrix}C_4H_5\\H\end{matrix}\right\}O_2$	$\left.\begin{matrix}53{\cdot}0\\6{\cdot}3\end{matrix}\right\}6{\cdot}2=$	62·8	62·2
Ether,	$\left.\begin{matrix}C_4H_5\\C_4H_5\end{matrix}\right\}O_2$	$\left.\begin{matrix}50{\cdot}3\\50{\cdot}3\end{matrix}\right\}6{\cdot}2=$	106·8	106·2
Acetic acid,	$\left.\begin{matrix}C_4H_3O_2\\H\end{matrix}\right\}O_2$	$\left.\begin{matrix}50{\cdot}3\\6{\cdot}3\end{matrix}\right\}6{\cdot}2=$	62·8	63·4
Anhydrous acetic acid,	$\left.\begin{matrix}C_4H_3O_2\\C_4H_3O_2\end{matrix}\right\}O_2$	$\left.\begin{matrix}50{\cdot}3\\50{\cdot}3\end{matrix}\right\}6{\cdot}2=$	106·8	109·9
Aldehyd,	$\left.\begin{matrix}C_4H_3O_2\\H\end{matrix}\right\}$	$\left.\begin{matrix}50{\cdot}3\\6{\cdot}3\end{matrix}\right\}=$	56·6	56·8
Aceton,	$\left.\begin{matrix}C_4H_3O_2\\C_2H_3\end{matrix}\right\}$	$\left.\begin{matrix}50{\cdot}3\\28{\cdot}3\end{matrix}\right\}=$	78·6	77·4
Benzol,	$\left.\begin{matrix}C^{12}H_5\\H\end{matrix}\right\}$	$\left.\begin{matrix}87{\cdot}9\\6{\cdot}3\end{matrix}\right\}=$	94·2	96·0

Kopp considers these results as shewing at least that in the acids $C^nH^nO_4$, 2 atoms of oxygen are contained in a different form from the other two. The author concludes his very interesting and able memoir by some judicious remarks on the value of physical characteristics considered in connection with chemical constitution.—*Ann. der Chemie und Pharmacie*, xcii, 1, *October*, 1854.

2. *On the employment of a solution of chlorid of iron in the galvanic battery.*—At the suggestion of Liebig, Buff has determined the electromotive force of a galvanic element consisting of zinc in contact with dilute sulphuric acid and carbon in contact with a solution of ses-

quichlorid of iron. The solution of the sesquichlorid must be acidulated with muriatic acid to prevent the deposition of metallic iron. A battery of this kind showed a satisfactory degree of constancy so long as the deviation of the needle of a tangent's compass did not exceed 14°. For deviation of 18° and upward a gradual diminution of constancy was perceptible which arose evidently from the fact that the hydrogen was evolved at the surface of the carbon more rapidly than it could be absorbed by the chlorine of the sesquichlorid. For a Bunsen's element the author found an electromotive force represented by 1·8167. For a cell of Daniell's battery the electromotive force was 1·0201; for another of the same 1·0316. For the sesquichlorid of iron battery with but a small quantity of free HCl the electromotive force was 1·3537; with a larger quantity of acid 1·3250; with a small quantity of free HCl and with a solution of common salt in the porous cell the electromotive force was 1·3958. From these results it is clear that the chlorid of iron battery stands between Bunsen's and Daniell's in point of constancy. It has greater power and constancy than Daniell's while it is perfectly free from the offensive vapors which render the use of the nitric acid batteries so annoying.—*Ann. der Chemie und Pharmacie*, xcii, 117.

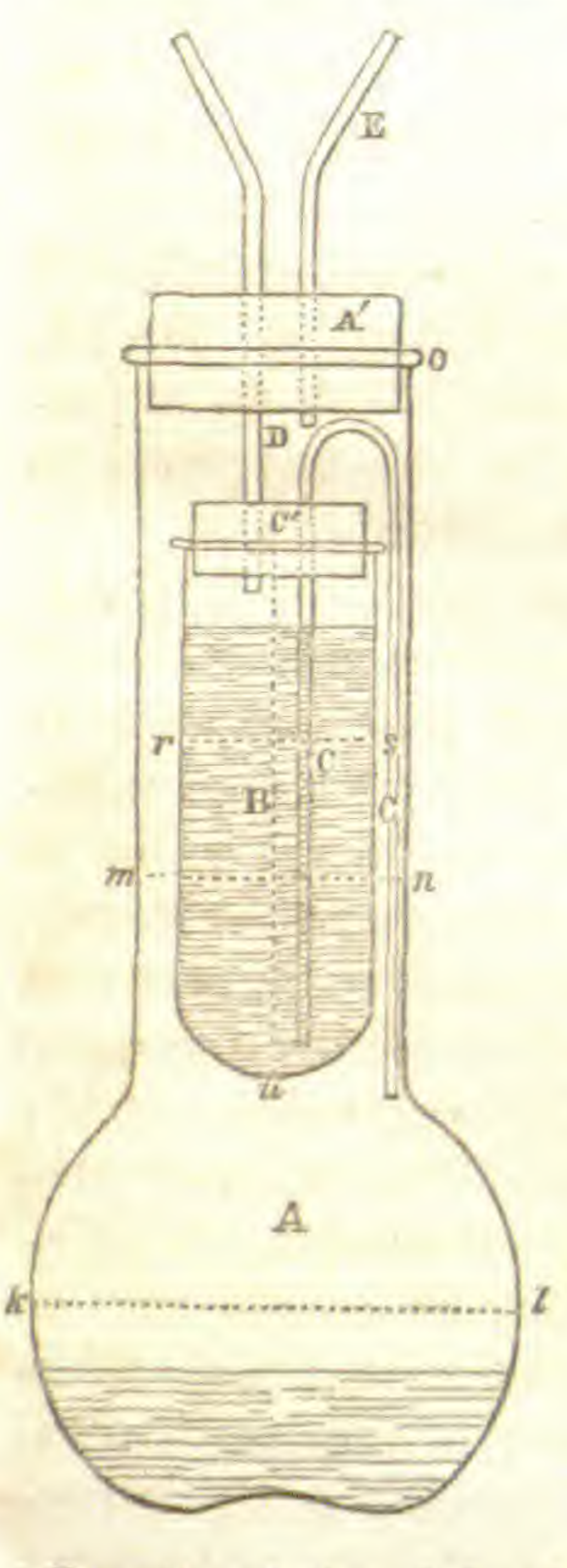
[NOTE.—Would not the solution of the sesquioxyd of iron which is obtained by the spontaneous oxydation of a solution of green vitriol in the air answer the above purpose as well as the sesquichlorid? Its conducting power would in all probability be much better and it would certainly be cheaper. Moreover the protosulphate of iron formed by the reducing process in the battery might be exposed to the air a second time and thus reoxydized and again employed.—W. G.]

3. *On the law of the absorption of gases.*—Bunsen has communicated a most admirable and elaborate investigation of the subject of the absorption of gases by liquids. As however it is impossible to do it justice by any abstract, we must refer our readers to the original paper in the *Ann. der Chemie und Pharmacie*, xciii, 1, *Jan.*, 1855.

4. *On the mechanical equivalent of heat.*—Upon this important subject, Person has contributed to the Academy of Sciences a note which possesses much interest. The author in the first place alludes to the different values of this constant as given by different experimenters, and then proceeds to show that we shall have the exact value as soon as we know the specific heat of air c at a constant volume, or rather, without external work. In the mean time however it is well to remark that the value of c taken from the formula of Laplace, which serves to correct the velocity of sound, gives a value of the mechanical equivalent closely agreeing with that found by Joule. The air which dilates without producing external work resumes in a few moments its primitive temperature, and in spite of its dilatation contains precisely as much heat as before. This principle is perfectly established by the recent researches of Regnault. Setting out from this fact we determine the mechanical equivalent of heat by a very simple reasoning. Consider a cubic meter of air at 0° under a normal pressure of H kilogrammes per square metre; let p be its weight and c its specific heat at a constant volume. If we give this air the heat $p\ c$ without permitting it to expand, the temperature will rise 1 degree and the pressure will become $(1+a)$ H where a is the coefficient 0·00367 If we then open a communication

with a vacuum we shall have the same temperature and the same quantity of heat in spite of the dilatation, and if the volume of the vacuum is the fraction a of the cubic metre the pressure will again become H. Now take again a cubic metre of air at 0° and under a pressure H, and let C denote the specific heat under a constant pressure. Give to this air the heat p C, permitting it this time to dilate under the pressure which it supports. We thus obtain a volume $1+a$ at 1° under a pressure H precisely as in the preceding case in which however we have only introduced the quantity of heat pc. But in the first case there was no external work, while in the second the dilatation a under the pressure H produced the work a H. As the two masses of air were identical in their initial and terminal states, they both contain precisely the same quantity of heat. We have therefore a right to conclude that the heat $p\,(C-c)$ is exclusively employed in producing the work a H. Consequently the work of the unit of heat is $\frac{aH}{p(C-c)}$. By taking the numbers $H=10334^k$, $p=1^k{\cdot}293$, $C=0{\cdot}1686$ according to Laplace, and $c=0{\cdot}2377$ according to Regnault, we find 424 kilogrammetres for the mechanical equivalent of heat.—*Comptes Rendus*, xxxix, 1131, *December*, 1854. W. G.

5. *A new Carbonic Acid Apparatus*; communicated by ALFRED M. MAYER, of Professor Morfit's Laboratory, University of Maryland.—



Length of line $k\,l$, $1\frac{1}{2}$ in.; $m\,n$ $1\frac{3}{16}$ in.; of $r\,s$ $\frac{7}{8}$ in.; of C′ u $2\frac{1}{4}$ in.; height of whole to O, $4\frac{3}{4}$ inches. Syphon C, 1-16th in.

Having lately invented an apparatus, for the estimation of carbonic acid in carbonates, or rather made a modification of Will's and Fresenius's apparatus, I have thought it might be of some service to science; and I therefore send you a drawing (half-size) with the dimensions marked. The following is the description of the drawing. A is a flask, at the bottom of which is placed the carbonate with a little water. B is a short piece of test tube closed with a cork perforated with two holes. C C is a syphon leading from the bottom of the tube to the flask. D is a hole passing from the tube B through the cork of the flask. E is another hole perforating the cork of the flask.

After the carbonate is introduced into the flask (A), the tube (B) is nearly filled with sulphuric acid, and being attached to the cork A′ by the tube D is inserted into the flask. The tube E is then closed with a small piece of wax or cork. Suction is then applied at the tube D; the air in B being rarefied, equilibrium is disturbed, and the air of the flask passes through the syphon into the tube B. When the mouth is removed, equilibrium is restored in B, but the air in A being rarefied, the acid passes over through the syphon tube to equalize the pressure. The acid coming in contact with the carbonate, the carbonic acid is set free and passses into the tube

C C through the sulphuric acid, where it is thoroughly dried, and out through the tube D. This is repeated until no more gas is disengaged; when the piece of wax is removed from the tube E, and the air is drawn through the apparatus by suction at D. When all the gas is out of the flask it is weighed; the loss of weight indicating the amount of CO_2.

The advantages which I think this form of apparatus has, are compactness, lightness, more convenient to weigh and in general easier in manipulation.

Baltimore, Feb. 13, 1855.

6. *On Bimucate of Amyl-oxyd;* by SAMUEL W. JOHNSON.*—In 1830, Malaguti described the neutral compounds of mucic acid with methyl- and ethyl-oxyd. He prepared these by dissolving the acid in warm oil of vitrol and adding to the deep-red solution after cooling, either wood-spirit or alcohol, without preventing the accompanying elevation of temperature. After twenty-four hours, the whole had solidified to a mass of crystals which was purified by washing with alcohol and recrystallization. The colorless crystals thus obtained are composed of one equivalent of acid and two equivalents of oxyd of the alcohol radical.

Afterwards Malaguti observed that an impure solution of the vinic ether sometimes decomposes, alcohol becoming free, and a bimucate of ethyl-oxyd or mucovinic acid is formed in the solution and may be separated in the crystalline state. This acid forms salts with bases.

Last winter in the laboratory of Prof. Erdmann at Leipsic, and at his suggestion, I undertook the study of the compounds of mucic acid with amyl-oxyd and communicate herewith the imperfect results of my investigations which have been necessarily suspended. Applying amyl-alcohol in the process of Malaguti, I obtained a crystalline ether, but only in a few of many trials, and when operating on small quantities. When, however, fuming hydrochloric acid was added to the mixture of mucic acid, amyl-alcohol and oil of vitriol, and the whole digested at a moderate heat for some hours, the new body was prepared without difficulty. The brown semi-solid mass thus obtained was washed with alcohol so long as that liquid ran off colored, and was then several times recrystallized from hot alcohol or water. As thus obtained, this ether usually appears in the form of a bulky opake mass of indistinct crystals; from a not too concentrated hot solution it separates as distinct transparent needles on slow cooling. When dry, it is tasteless, has a fatty feel, and is scarcely wetted by water, more easily by alcohol. It gives a distinct acid reaction when laid on moist litmus-paper. By combustion with oxyd of copper the following results were obtained on distinct preparations, which agree with the formula $C_{10}H_{11}O, HO, C_{12}H_8O_{14}$.

	Calculated.		Found. 1.†	Found. 2.†
C_{22}	132	47·14	46·99	46·68
H_{20}	20	7·14	7·08	7·29
O_{16}	128	35·72	45·93	46·03
	280	100·00	100·00	100·00

* From the "Jour. für Prakt. Chem.:" communicated to this Journal by the author.

† 1st, ·3325 gm. gave ·573 gm. CO_2 and ·212 gm. HO.—2d, ·2623 gm. gave ·4491 gm. CO_2 and ·1723 gm. HO.

The substance is accordingly bimucate of amyl-oxyd or mucamylic acid. When pure, its solution is not precipitated by salts of lead, silver or baryta, nor by ammonia. With the latter, as with caustic potash and soda, it instantly decomposes, amyl-alcohol being set free. Its boiling aqueous solution smells faintly of fusel oil, owing to gradual decomposition; its cold solutions become mouldy in warm weather but do not appear to undergo decomposition. It is incapable of expelling carbonic acid from its weakest combinations.

The mother liquors sometimes yielded a slight white precipitate with ammonia which may have been *mucamid*, thus making the existence of the neutral ether probable. That body was not however obtained separately.

It is not a little remarkable, that while in the ethyl series the neutral mucic ether is easily obtained, and the acid ether rarely and by chance, in the amyl series the acid is of easy preparation, while the neutral compound is not obtained.

It is further remarkable, that this ether, so stable in solution and in the presence of alkalies, is, unlike the analogous ethyl compound, immediately decomposed by soluble bases.

7. *On Terrestrial Magnetism;* by Col. SABINE, (communicated for this Journal, by J. RENWICK.)—Col. Sabine, V.P.R.S., communicated to the British Association, 25th September, 1854, a very remarkable and important paper on terrestrial magnetism. It will be recollected that at the meeting of the Association in 1838, a request was made to the British government that it should cause observations on the phenommena of magnetism by officers of the army and navy to be made at fixed stations, and by means of naval expeditions. The request was promptly acceded to, and Col. Sabine, who was and has continued on duty at Woolwich was made the centre of communication. The readers of our Journal will have seen that various Americans have entered zealously into the same pursuit, and the observations of others are intercalated with, and form a part of, the observations, whose results we are about to state.

As early as 1825, Col. Sabine had inferred that an influence was exerted by the sun and moon on terrestrial magnetism. In a set of observations taken at the winter station of one of the Polar Expeditions where the declination was about 90°, and discussed by him, it was remarked: that when the Sun and Moon were on the meridian at the same time, the diurnal variation reached 5°; but that when they were at right angles to each other this quantity fell as low as 20′. The sagacity he exhibited in his inference from this isolated set of observations has been sustained by the laborious and patient observations and discussions of fifteen years. Some quantities so minute are developed in the researches, that a less time would hardly have served to separate them from the larger quantities in which they are involved. The results set forth by Col. Sabine are as follows:

(1.) The diurnal variation, following in all places the order of solar time, and being at its maximum about two hours after noon, changes its sign at the time of the two equinoxes. Thus, while the maximum diurnal deflection from the magnetic meridian is eastward in all places up to the 21st March, a change in the amount of deviation begins on the 22d, and is completed in about ten days, after which the maximum daily variation is to the westward, and at a mean equal to the eastern variation of the preceding six months.

(2.) There is an annual variation in the intensity of terrestrial magnetism, of small amount indeed, but affecting both the northern and southern hemisphere in the same manner, the intensity being greatest when the sun is in perigee, and least when it is in apogee.

(3.) It being well known that all the instruments in magnetic observation are from time affected by disturbances, or *storms* as they are often called, these disturbances have been found to be subject to a periodic fluctuation. This period has been discovered to correspond with that assigned by Schabe to the spots on the solar disc.

(4.) It has been clearly shown that there is a variation in magnetic declination dependent on the change of the moon's position in relation to the meridian of the place of observation, and having, therefore, for its period the lunar day. This although first inferred by Sabine from a single set of observations, was fully proved by Kriel from observations made in the Austrian States before the publication of the paper of which we are stating the substance.

Finally, the hypothesis which ascribes the variations in the phenomena of terrestrial magnetism to local variations of temperature is completely refuted.

May we not hope, that the relations of the magnetism of the earth to the two heavenly bodies which exert the greatest influence in other respects upon our planet, having been thus conclusively shown, a basis is now provided upon which to erect a science that will be as simple in its laws, and as fertile in its results as the theory of universal gravitation? Up to the present time, terrestrial magnetism as a science has had no other foundation than vague and unsupported hypotheses, or empiric propositions, which although true, have been founded on no general law. Henceforth it would appear to be as closely within the reach of mathematical methods as the tides.

7. *On the Stauroscope of Prof. Fr. von Kobell,* (translated for this Journal by S. W. Johnson, from a paper by von Kobell; also see Gelehrte Anzeigen, Mar. 30 and April 2, 1855)—This instrument consists of two cylinders as shown in figure 1, one of which *aaaa*, is firmly fixed in a ring, which is attached to a support in such a way as to be inclined at convenience (fig. 4). The fixed cylinder has at one end a polarizing apparatus consisting of a tourmaline plate 1, and a plate of calcite 2 with polished basal planes (= 0R). Through an orifice in the disk *aa*, the eye looks through the instrument upon a horizontal mirror of black glass, upon which, by proper revolutions of the tourmaline, is seen the well known black cross. At its lower end, this cylinder has a graduated semicircle (fig. 2, half size) marking 90° either side of a common zero, which zero coincides with the plane of the axis of the tourmaline. The inner cylinder is open at both ends, slides into, and is moveable within, the other. At its upper end it has a ring fixed within it, which serves to support the circular perforated plates or diaphragms upon which the crystals are mounted for observation. The position of the crystals to be examined is shown at 3, fig. 1. Figure 3 represents one of the circular diaphragms upon which is accurately

engraved a square, *ab;* a crystal is seen upon it secured with wax, *a′ b′ ;* at its centre is seen the orifice for the passage of the light, its size corresponding to that of the crystal to be examined : at some point on the edge is made a notch, which is adapted to a pin secured to the inside of the tube so that the position of the diaphragm shall remain fixed. By these means, the crystal under examination may be properly adjusted ; two sides of the engraved square must coincide with the axis of the analyzing tourmaline, while two are at right angles with it. The movable cylinder carries an index, fig. 1, *z*, which traverses the graduations of the graduated semicircle.

If now a cleavage plate of calcite be so fixed upon the diaphragm that *a′ b′* is parallel with *a b* of the engraved square as in fig. 3, and the movable cylinder be adjusted to zero, then *a′ b′* is also parallel with the longitudinal axis of the tourmaline, and no black cross is visible. The cylinder must now be turned until the cross appears normal, and the angle of revolution may be read off on the graduation.

I have investigated various crystals in this manner, and have arrived at the following results which in general characterize the systems of crystallization.

Hexagonal System.—Through parallel planes of the *hexagonal pyramid*, the vertical arm of the black cross is seen at right angles to the basal edge (edge Z). Through parallel planes of the *rhombohedron* the cross arranges itself in the direction of the diagonals. Through the planes of the *prism*, the vertical arm of the black cross stands in the direction of the principle axis. Examples, quartz, calcite, beryl, soda nitre, corundum, apatite.

Seen through the basal planes, the cross is not changed by a revolution of the cylinder. (Tourmaline has peculiarities, the account of which is here omitted.)

Dimetric System.—Through parallel planes of the *square pyramid*, the same relation was observed as in the hexagonal system : the same is true also for the planes of the prism, and the basal planes.

When the edges of the pyramid are laid horizontal the cross appears revolved. Ex. meionite, vesuvian, apophyllite, zircon, mellite, chalcolite, rutile, etc.

Trimetric System.—Seen through two parallel planes of the *rhombic pyramid* the normal arm of the cross is not at right angles with the basal edge. Ex. sulphate of zinc, of magnesia, and of nickel, topaz,* &c.

Seen through the basal planes of the *rhombic prism*, the cross takes the direction of the diagonals. Ex. epsomite, topaz, muscovite, aragonite, barytes, &c.

Through the lateral faces of the vertical rhombic and rectangular prisms, the cross stands in the direction of the vertical axis. Ex. anhydrite, &c.

Through the faces of the domes, the normal arm of the cross is at right angles with the terminal edge of the dome. Ex. epsomite, &c.

Monoclinic System.—Through the oblique terminal planes the cross stands in the direction of the diagonals. Through the lateral planes

* In general the angle of revolution upon the triangles of the pyramids of the dimetric and hexagonal systems are of two kinds, but in case of the trimetric system of three kinds.

Von Kobell's Stauroscope.

of the prism the cross does not stand in the direction of the principal axis and the system is thus distinguished from the Trimetric.

Through the orthodiagonal planes the cross stands in the direction of the principal axis. Through the clinodiagonal planes it is not in the direction of the principal axis. These planes comport themselves very different from the similar ones in the rhombic system.

Through the *clinodiagonal domes* the cross also appears revolved. Ex. orthoclase, augite, cane sugar, gypsum, borax, bicarbonate of potash, glauber salt, euclase.

TRICLINIC SYSTEM.—The cross is oblique upon all planes, if an edge of the prism be placed parallel with the axis of the tourmaline. Ex., kyanite, bichromate of potash.

Boracite is plainly doubly refractive. Yellow prussiate of potash is optically binaxial. Prof. von Kobell describes peculiarities in several species, which are here omitted.

II. MINERALOGY AND GEOLOGY.

1. *Mineralogical Notes ;* by T. S. HUNT.—*Pyrrhotine.*—This species with the formula $Fe_7 S_8$, is regarded by Laurent as a protosulphuret in which a portion of iron exists as *ferricum*, (fe) with two-thirds its ordinary equivalent; the formula of the mineral is then $(Fe_5\ fe_3) S_8$ According to Schaffgotsch, some varieties have the composition $Fe S$, $Fe_2 S_3 = Fe_3 S_4$ or $(Fe\ fe_3) S_4$, corresponding to magnetite $Fe_3 O_4$ or $(Fe\ fe_3) O_4$. By thus regarding it as a protosulphuret, its relation to Greenockite is more apparent.

Wilsonite.—The further examination of specimens of the mineral Wilsonite in the possession of Prof. E. J. Chapman has shown him that the form of this mineral is triclinic with inclination to the right. He gives as approximations the following angles obtained by the common goniometer with cleavage surfaces. $P : T = 94°$; $P : e = 145°$; $T : e = 129°$; $P : M$ and $T : M = 110°$ to $115°$. Cleavage perfect with P and T, less so with M. The cleavage with *e*, according to Chapman, " is not easily obtained, but is very distinct and even. Density 2·77. Hardness 3·5 cn the more facile cleavages, and their combination edges ; 5·5 on the ends of the prismatic concretions." Prof. Chapman also pointed out to me the existence of intermingled carbonate of lime in the specimens which I had previously analyzed, and I have since found that the finely pulverized mineral yields up almost the whole of its lime to cold dilute hydrochloric acid, which does not attack the silicate. This still retains its rose color, and is a hydrous silicate of alumina and potash, with a little magnesia. The results of the analyis by myself of two specimens thus purified, (1 and 2,) and a partial analysis kindly furnished me by Prof. Croft, of a third, are as follows :

	I.	II.	III.
Silica,	47 50	47·70	47·42
Alumina,	31·17	31·22 }	34·80
Magnesia,	4·25	4·14 }	·73
Potash,	9·22	9·38	
Soda,	·82	·95	
Lime,	1·51	·39	·42
Water, (loss by ignition),	5·50	5·35	
	99·97	99·13	

The pure mineral from which the carbonate of lime has been removed, seems to be uniform in composition, and approaches the feldspars in constitution.

Bytownite.—Bytownite I suppose to be anorthite with some quartz, or more probably a mixture of different feldspars. It is very similar in composition to Genth's thiorsauite. All those triclinic feldspars intermediate in composition between anorthite and albite, appear to be only crystalline mixtures of these two species. See Am. Jour. of Science, [2], xviii, 270.

Magnesite.—A silicious magnesite rock of considerable extent is found among the strata of the Hudson River group in Bolton, Lower Canada. Its analysis gave carbonate of magnesia, 60·13, carbonate of iron 8·32, silica with a little chromic oxyd 32·20=100·65. The serpentines of this formation are believed to result from the alteration of this silicious carbonate, in the presence of water. (See Geol. Rep. Canada.)

Dolomite—A very compact, fine grained coral limestone from the Island of Matea, north of Tahiti, furnished me by Mr. Dana from the Collections of the U. S. Expl. Expedition, has a hardness greater than fluor; and a density in powder, equal to 2·830. Its analysis gave Carbonate of lime 60·50, carbonate of magnesia 38·77, silica, etc., 0·30= 99·57. Another determination gave 38·25 of carbonate of magnesia.

[This analysis confirms the result of Prof. Silliman, Jr., (this Jour., [2], xiv, 82) and shows that the dolomisation took place in the consolidation of the coral material. The rock is the white compact limestone of Matea, an elevated coral island, and resembles much of the rock found about other reefs. It is as solid and firm as any Silurian limestone. See the writer's Geol. Report, and also this Jour., xiv, 76.—J. D. D.]

2. *Notice of a new Locality of Molybdate of Iron?* by WM. J. TAYLOR.—I obtained in September last a mineral from Heard County, Georgia, which resembles in every respect the molybdate of iron, recently described by D. D. Owen, (Proc. Ac. Nat. Sci. Philad., vi, 108), from the gold region, near Nevada city, California. It consists of deep yellow, silky tufts, formed by groups of delicate, acicular crystals, coating and filling the cavities of dark ferruginous quartz.

This quartz forms numerous veins in micaceous and granitic rocks, in a district where gold has been found.

A qualitative analysis showed $\ddot{\mathrm{M}}\mathrm{o}$, $\bar{\mathrm{F}}\mathrm{e}$. It has been as yet impossible to obtain sufficient of the mineral for a thorough quantitative analysis.

3. *Reaction of common salt in the formation of Minerals;* M. FORCHHAMMER.—On fusing together phosphate of lime (the phosphate of bones) and chlorid of sodium (four parts to one of the phosphate) he obtained after a slow cooling a mass in which were many cavities covered with prismatic hexagonal crystals, which were apatite in composition; the specific gravity 3·069. At the temperature of fusing, apatite dissolves readily in common salt and separates in needle-form crystals. By this method small quantities of phosphoric acid in rocks may be detected; they are to be melted with 50 to 100 parts of common salt, and if easily fusible the silicates separate easily from the salt; if not, chlorid of sodium fills the cavities in the vesicular mass, resembling the cavities in an amygdaloid. M. Forchhammer concludes that common salt has played an important part in the formation of minerals.—*Pogg. Ann.*, xci, 568.

4. *Gneiss.*—Analyses by F. Schönfeld and H. E. Roscoe, (Ann. Ch. u. Pharm., xci, 302.)—1, a mica slate from the right shore of the Eisack G. =3·1410; 2, gneiss from Cachoeria da Campo, Brazil, consisting of orthoclase, quartz, and mica, yellowish-gray in color, G. =2·6128; 3, so-called protogine, from the north side of Mont Blanc, a hundred feet below the highest peak, G. =2·7088; 4, gneiss from Norberg, Sweden, consisting of flesh-colored orthoclase, quartz, and grayish-black mica; 5, ibid., a fine grained mixture of orthoclase and quartz.

	$\ddot{S}i$	$\bar{A}l$	$\dot{F}e$	$\dot{C}a$	$\dot{M}g$	$\dot{K}$	$\dot{N}a$	H	
1. Mica slate,	69·45	14·24	6·54	2·66	1·35	2·52	4·02	0·52	=101·30
2. Gneiss,	67·32	16·08	4·52	3·87	1·54	5·08	2·98	0·43	=101·82
3. Protogine,	71·41	14·45	2·58	2·49	1·11	2·77	3·05	1·25	= 99·11
4. Gneiss,	74·51	13·05	3·85	3·26	0·48	2·31	3·64	——	=101·10
5. "	76·55	12·86	0·85	2·47	0·12	5·29	3·03	——	=101·17

5. *Meteoric Iron from Greenland.*—Forchhammer describes this mass as weighing 21 pounds; it is 7 inches long, 7 high and 5½ broad. Specific gravity 7·00–7·02, Rinck. Hardness like that of steel. With nitric acid affords fine Widmanstättian figures. Composition (Pogg. Ann., xciii, 155)

Fe 93·39 Ni 1·56 Co 0·25 Cu 0·45 S 0·67 Ph 0·18 C 1·69 Si 0·38=98·57

The large proportion of carbon is peculiar.

6. *On the Sandstone and Coal of North Carolina of the age of the Richmond coal basin;* by Prof. D. OLMSTED.*—[The following observations are from the Geological Report on North Carolina, by Prof. D. Olmsted, published in 1824, the first of all the State Geological Reports, made in this country. The facts have not appeared in this Journal, and as the Report was long since out of print, we republish them. The author, at the time when the investigations were made, was Professor of Chemistry and Mineralogy in the Universtity of North Carolina.]

Freestone and Coal formation of Orange and Chatham.—"The formation is very extensive, embracing a great number of beds of excellent freestone, varying among themselves in color and texture, but nearly all extremely well suited to the purposes of architecture. The sandstone extends from Oxford in a southerly direction, quite through the State. Its length, within our own State, is about 120 miles. The breadth of the formation varies considerably in different places. On the southeast of Oxford it disappears among the valleys, converging almost to a point; on the Neuse, its breadth is about 12 miles; between Raleigh and Chapel Hill, it is 18 miles; not more than 8 miles on the Cape Fear, but southward of that, it grows a little wider. Its average breadth may therefore be stated at about 12 miles. On this supposition, the whole area of the formation is 1440 miles. In going from Oxford to Chapel Hill, the traveller passes nearly on the line of its western boundary. This runs onward, at the foot of Chapel Hill, a mile and a half east of the University; meets Haw River about three miles above Haywood, and Deep River five miles northwest of Tyson's Mills. Thence it passes through Moore County, by Richland Creek; thence

* Professor Olmsted's first announcement of these coal mines will be found in this Journal, ii, 175, 1820, and v, 228, 1822. An abstract of a paper on these mines by Professor W. R. Johnston is contained in Proc. Amer. Assoc., iv, 274, New Haven meeting, 1850.

into Montgomery by Cheek's Creek; and finally through Anson, a few miles above Wadesborough, into South Carolina. The eastern boundary will be indicated with sufficient exactness, by mentioning the points where the roads meet it, that diverge westward from Raleigh. On the road to the Fishdam, on the Neuse, the sandstone begins to appear two miles north of Boyce's Mills, and five from the Fishdam, on the same road. On the western road to Hillsborough, the line of the formation passes a little east of Brassfield's. The same line is met with on the way to Chapel Hill, near Mrs. Jones's on Crabtree Creek, twelve miles from Raleigh. Farther south it is found five miles below Haywood, on the Cape Fear, and not far from Sneedsborough, in the County of Anson. * * *

"Red is the predominant color of the sandstone; but several shades of this are exhibited, and a light gray and a dull yellow are not unfrequent colors. All these varieties are often contained in the same bed within a few feet of each other. A similar diversity prevails in the texture of this rock. It is sometimes very finely grained, sometimes very coarse: in one place, the grains are very closely cemented together, forming a hard, firm rock; in another, they cohere loosely, and the rock is proportionably friable and destitute of strength. It is important to note all these circumstances, to show that there is much reason for examining with care and pains in selecting materials for building or other purposes. * * *

"This region of sandstone embraces several beds of that conglomerate rock which is used for millstones. But the most distinguished locality of the millstone grit occurs on Richland Creek, in Moore County, near the western limit of the formation. The importance of this article, and the probability of finding it in other parts of the sandstone region, will justify some degree of minuteness in speaking of it. This excellent bed of millstone grit is exposed to view directly on the bank of the Creek, forming three horizontal strata or layers, each composed of large tabular masses. The lowest stratum is of the best quality for millstones. It consists of a hard, grayish red sandstone, in which are thickly imbedded water-worn pebbles of white flint or quartz.

"This formation may be considered as a continuation of the Richmond coal deposit, and both are believed to be a continuation of a long and narrow deposit of sandstone which extends from Connecticut River to the Rappahannock.* Indications of coal have been observed in va-

* Mr. M'Clure, the distinguished President of the American Geological Society, has traced the above formation of sandstone for an extent of 400 miles to the Rappahannock, where he supposes it to terminate on the south. Of the Richmond basin he remarks, that "it would not be far distant from the range of the red sandstone formation had it continued so far south." Our sandstone formation, which lies in the same range, was not known to geologists at that time. From an entire similarity in the rocks, as well as from a coincidence in their range, I have little doubt that both the Richmond and the North Carolina sandstone belong to the same formation with that north of the Rappahannock. The sandstone and coal deposit of Richmond or Chesterfield, has a greater extent than was believed by Mr. M'Clure, being 60 or 70 miles instead of 20, as he supposed, and if we add to this 120 miles, the length of our sandstone deposit within this State, (and I know not how far it extends into South Carolina,) we make nearly 200 miles, which is half the length of the whole range north of the Rappahannock. (Vide M'Clure's Obs. on the Geology of the U States, p. 44.)—[These distant deposits are now known to be of the same age and formation, though not continuous, and belonging to different valleys.]

rious parts of this range. The mine in Chesterfield County, between the James and Appomatox Rivers, in Virginia, has been wrought to some extent, and furnishes at present a considerable article of commerce. * * *

"In the third place, in addition to the foregoing presumptions that coal might be found in the district of country under consideration, we have it in our power to say, that coal has actually been discovered in this region, and that a bed of considerable extent has been opened not far from the Gulf on Deep River.

"It is about fifty years since this coal-bed was first discovered. Mr. Wilcox, an enterprising gentleman, proprietor of the Old Iron Works at the Gulf, took some pains to have it opened, and to introduce the coal into use. Blacksmiths from different parts of Great Britain made trial of it, and concurred in pronouncing it to be of excellent quality. During the life-time of Mr. Wilcox, it was freely employed in the vicinity, although the want of water carriage prevented its being transported to a distant market. For some years past the mine has been neglected, and at the time of my visit, it was not in a favorable state for observation. The principal excavation is one-fourth of a mile North of Deep River, on a ridge elevated but a few feet above the general level of the country, and distinguished from all the other ridges in the district, by consisting chiefly of a finely divided black slate. The present edge of the bed is about ten feet below the surface of the ground, and dips to the southeast at an angle of about twenty degrees. The thickness of the bed when entirely exposed, according to Mr. Tyson, the proprietor, is about one foot. The water and rubbish with which the pit was encumbered, did not permit my ascertaining the facts respecting it so much from personal observation as I desired, but the respectable proprietor assured me, that waggon loads of the coal could be obtained with ease. The coal is highly bituminous, burns readily with a bright flame, and is, I think, of much the same quality with the Richmond, or the Liverpool coal.

"With regard to the *extent* of this coal mine, I have no means of judging with much certainty. On the road from Salem to Fayetteville, by way of Tyson's Mills on Deep River, the traveller crosses a number of ridges of that shelly kind of black slate which is the accompaniment of the coal, and may be considered as a symptom of it wherever it occurs. This however passes under a soft red rock, called by geologists slaty clay, which extends southward towards Moore Court House, and nothing is seen of the black slate on the south side of the River. * * Coal is found also in the County of Rockingham, and the subject will be resumed should a subsequent Report lead me to speak of the geology of that region. * * *

"A marly kind of limestone is found connected with the sandstone near its eastern limit, not far from Brassfield's, in the County of Wake. It does not appear to be extensive, nor is its quality good. But though unsuitable for making good quicklime, it would probably be found a useful kind of manure. These soft and marly kinds of limestone, when pulverized and spread on land, often prove very fertilizing. But a more extensive deposit of limestone, and that of a better quality, may be reasonably looked for in the neighborhood of the coal.

"The color of this species of limestone is never white, but is dark, varying from gray to black. It is frequently nearly of a slate color, and is sometimes fetid, especially when two pieces are rubbed together. * * *

"Limestone has been discovered among the coal beds of Moore County, though as yet it has not been found to any great extent. I was informed by the late Murdock M'Kenzie, Esq., that it was formerly obtained in such quantities as to be employed in the reduction of Iron ore at Wilcox's Old Furnace; and that traces of it were found to the distance of seven or eight miles south of Deep River; but I cannot learn that any one has discovered it, except in detached nodular pieces, though I cannot but think there is some encouragement to look for it in that region.

"Iron ore is found near the western line of the freestone and coal formation, where small quantities were formerly obtained for the iron Works on Deep River. It consists of iron mixed with a large quantity of clay, but is so easily quarried and broken up as to become in many instances a profitable ore. * * *

"To sum up what has been said, it appears that the district of country which contains what I have called the freestone and coal formation of Orange and Chatham, affords materials for various purposes of architecture, for millstones, for grindstones and whetstones; that it embraces a bed of bituminous coal of unknown extent; and that, both from indications already remarked, and from established geological principles, hopes may reasonably be entertained that the same region will yield a supply of limestone and iron ore, and possibly of salt and gypsum."

6. *Preliminary Geological Report of the U. S. Pacific Railroad Survey, under the command of Lieut. R. S. Williamson*, Corps of Top. Eng., 1853; by W. P. Blake, Geologist of the Survey.—This Preliminary Report is to be followed by a detailed account of the regions examined, and we defer an extended notice till the latter appears. Part of the facts have already been published in this Journal. We cite some observations on Bitumen Springs,—p. 68. It is an interesting fact, which I believe is not generally known, that there are numerous places in the Coast Mountains, south of San Francisco, where *bitumen* exudes from the ground, and spreads in great quantity over the surface. These places are known as *Tar Springs*, and are most numerous in the vicinity of Los Angeles. It is also common to meet with large quantities of this material floating on the Pacific, west of Los Angeles, and northward towards Point Conception. I have seen it, when, passing this point, floating about in large black sheets and masses. They are probably the product of submarine springs; or they may be floated down by small streams from the interior.*

Some of the springs that I examined near Los Angeles were nothing more than overflows of bitumen or asphalt from a small aperture, around which it had spread out so as to cover a circular

* I am informed by Lieutenant W. P. Trowbridge, of the United States Engineer Corps, that the channel between Santa Barbara and the Islands is sometimes covered with a film of mineral oil, giving to the surface the beautiful prismatic hues that are produced when oil is poured on water.

space of about thirty feet in diameter. This had hardened by exposure, and was covered and mingled with dust and sand, which quickly adheres to its clean and fluid surface. The outer portions were hard as a pavement; and the mass was highest towards the centre, where it was soft and fluid, like melted pitch. It was thus evident that all the hard portions had risen in a fluid state, and by the heat of the sun had been gradually spread out over the surface. Being constantly exposed to the dust, it had become so thoroughly incorporated with the asphalt that the compound had all the consistency of an artificial admixture.

The spring that I have described is one of several similar ones, on the bank of a small brook about seven miles from Los Angeles.

I passed up and down the stream just mentioned for a short distance, on each side, and found one or two natural exposures of the edges of nearly horizontal shales of a light color, and very thinly stratified. The lowest layers were charged with *bitumen*, and were of various shades of brown and black.

These shales were principally silicious, and were overlaid by a stratum of pebbles and sand, probably beach-shingle.

Bituminous shales are also exposed in the harbor of San Pedro, near the base of the vertical bluffs of sedimentary formations along the beach. They have a dark brown or black color, and appear to be argillaceous. They emit a strong bituminous odor when struck by the hammer.

7. *Notes on some Fossils of the so-called Taconic System described by Dr. Emmons;* by James Hall, (from a letter to one of the Editors of this Journal.)—*Nemapodia*, Emmons. Some years since it was discovered by Dr. Fitch that the Nemapodia was the track of a slug or worm over the rusty-looking surface of the rock. To the naked eye the surface appears simply of a brownish or grayish brown color, the color being due to granules which are removed by the passage of the animal.

Nereites.—The Nereites are from Maine, and belong to slates probably of carboniferous or devonian age. None of the fossils of the Maine slates referred by Dr. Emmons to the Taconic System, are identical with those of the original Taconic rocks of New York.

Gordia marina.—I stated in my Palæontology of New York (vol. i, p. 319) that the *Gordia marina* presents no evidence of organic structure, and has the appearance of the cast of a furrow made perhaps by some mollusc, which was afterwards filled with mud. Dr. Fitch in 1848, in his Geological Survey of Washington Co., demonstrated that it was the track of some marine animal, and proposed for it the unwieldy name *Helminthoidichnites*, calling one species, a line wide, *H. marina*, and another half as wide, *H. tenuis.* He shows that the worm has pushed before it sometimes a grain of sand, until the mud was piled up so as to be an obstruction and then the animal rose over it.

Trilobites.—The Trilobite *Olenus* (*Elliptocephalus*) *Asaphoides*, and another species, have lately been found in the slates of Vermont in such a relative position to the limestones below, as to leave no doubt as to their age. Dr. Fitch found *Trinucleus concentricus* in the shales of Mt. Toby in Washington Co., reputed Taconic; and Prof. Adams found *Chætetes* and several other Hudson River fossils in the same position.

Fucoids.—The *F. simplex* is undoubtedly a graptolite, and is apparently identical with a species in the unaltered slates of the Hudson river group. The *F. rigida* (which is the same as F. flexuosa) is beyond doubt a Hudson river species.

Becraft's mountain, east of Hudson, 3 miles from the Hudson river, is composed of lower Helderberg limestones resting on Hudson river slates more or less folded and contorted; and it has in general the same elevation as the continuous range of the Helderberg on the west side of the Hudson. In the Helderberg, the rocks are nearly undisturbed, the Helderberg limestones above and the Hudson river slates below being nearly horizontal. The locality east of the Hudson is in the Taconic region. Had there been the great fault along the Hudson which the author of the Taconic System supposed, how could the Helderberg limestone have found a place here, over the so-called Taconic slates? The facts show plainly that the slates below, are no other than the Hudson river slates, as I have before observed.

8. *Dolomisation.*—M. Delanoüe denies that dolomisation is a result accompanying the alteration of rocks: and takes the ground that crystalline dolomites were dolomites in composition before the crystallization. He has analyzed altered limestones which were regarded from their appearance as dolomites and found them to contain no magnesia.—*L'Institut*, *No.* 1801.

9. *Mikrogeologie: Das Erden und Felsen schaffende Wirken des unsichtbar kleinen selbstandigen Lebens auf der Erde*, von C. G. Ehrenberg. 1 vol. folio, with 41 plates. *Leipsic*, 1854. Price $72.—A large portion of the text, with 41 folio plates of this magnificent and long expected volume is now published, giving the results of fourteen years of zealous and unwearied labor on the part of the distinguished author in accumulating and arranging for the benefit of science all the facts connected with the geological influence of microscopic life. The work, as its title imports, is strictly a geological one; but geological in the widest sense of the term, including the past and present, the air and waters, as well as the solid strata of the earth. The author states in the introduction, p. ix, that his great work, "Die Infusionthierschen," published in 1838, is to be considered as an introduction to the present volume, and we notice in various parts of the present work that not one of the much controverted positions assumed in the former work has been yielded. The term *Polygastrica* is retained; implying of course that the views of the author with regard to the intestinal canal and gastric pouches of the Infusoria are still unchanged. The Bacillaria and many other forms, removed to the vegetable kingdom by many writers of the present day, are still classed by the author as animals; his views being supported by the following remarks (*l. c.*, p. xi):

"As early as 1830 the process of feeding with indigo and carmine had so fully demonstrated the digestive apparatus and the active power of nourishment in microscopical animals, that the want of acknowledgment of the same is only due to faults in the manipulation of observers. Where the introduction of solid matter into the interior of minute forms takes place, the animal character is decidedly proved: therefore, in spite of all contradiction, the rock-forming Bacillaria are for ever established as no plants, but as silicious-shelled polygastric animals."

The author divides all the microscopic forms connected with geology into the following classes:

A. Silicious.	B. Calcareous.
Class 1. Polygastrica,	Class 5. Polythalamia,
" 2. Polycistinæ,	" 6. Zoolitharia.
" 3. Phytolitharia,	
" 4. Geolitharia.	

The classes just mentioned are treated of in the present volume with reference 1st, to Freshwater formations; 2d, to Marine deposits; 3d, to minute life transported by the atmosphere. The published portion of the text which amounts to 374 pages is devoted to the freshwater formations and completes the account of that division for all parts of the world except Europe and North America. The plates, 41 in number, contain over 4000 figures drawn by the author from carefully preserved specimens, and with a few exceptions represent the objects as magnified 300 times in diameter. It is evident that no expense of labor has been spared in making either the drawings or the engravings; and so far as accurate outlines and elegant artistic effect is concerned, few faults can be found with them: but we must express one disappointment with regard to the details of many of the figures. A *good* magnifying power of 300 diameters ought to show much more than these figures present, and to give means of distinguishing between allied forms which these drawings fail to furnish. That the author has most faithfully attempted to represent all he saw we have no doubt; but as he states that from 1832 up to the present time, he has made *almost* exclusive use of a microscope made by Schiek, it is obvious enough why he did not see more, and we can but regret that so excellent an observer has not been tempted at least to try if more might not be seen with the undoubtedly superior lenses made in London and in this country. While so many of his views are controverted, one would suppose that he would not rest satisfied with an instrument made over twenty years ago, when such vast improvements in microscopes have been made within the last ten years. There is another thing with regard to the plates which appears to us ill judged. The attempt is made to represent for each locality the most important and characteristic forms belonging to it, which is doubtless convenient; but in our opinion the value of the work would have been greatly enhanced by giving *one* good figure for each of the species, instead of repeating over and over again on different plates, and in some cases over on the same plate, the figures of well known forms. Who would not prefer to have a complete series of all the known species instead of this constant repetition of forms for each of which one good figure would suffice?

In turning over the plates and their accompanying explanations we find that on one plate is represented one of the microscopic forms from the deep soundings of the Atlantic of which we published an account in a former volume of this Journal. The author's results are in perfect agreement with our own except that he applied acid to a portion of the material, and thus detected a small amount of inorganic mineral matter which we overlooked. We must however beg leave to differ from the author with regard to the origin of the plants which he evidently supposes to have grown at the bottom of the ocean, and which he has represented in Pl. 35, B. iv, 25, 26 and named Hygrocrocis spongiacea, and

Hygrocrocis Erebi. These plants are beyond a doubt merely minute fungi or moulds which have developed themselves in the damp bottles at the expense of the sizing of the paper in which the soundings were enveloped, or of the organic matters contained in the mud. In one of our bottles of similar materials these plants have developed into conspicuous patches of mould with tufts of spores, and we have now no doubt that the minute bodies in these soundings which we once mistook for the ova of Polythalamia (see Smithsonian Contributions to Knowledge, ii, 13) are merely the spores of these Fungi.

The text so far as published is full of detailed and interesting accounts of foreign localities of microscopic beings of freshwater origin, and the plates promise a rich treat when the text for the remaining portion shall be completed. Our own country is largely represented by figures of fossils from numerous localities, but the text relating to them is not yet published.

We trust that the author will give, either in the present volume or in a supplement, a revision of the generic and specific characters of all his species. At present all that we know about many of them is from the brief characteristics published in the Berlin Reports. These are excellent as far as they go; but are at fault in some respects in consequence of the use of too low a magnifying power, and the frequent reference to apertures where none exist. We think too that some, but by no means all, of the changes, suggested by recent writers on these minute bodies, are worthy of adoption. When the portion of the text which refers to North America reaches us, we propose to make extracts for this Journal of the most interesting portions. In the mean time, we commend this volume to all lovers of the microscope, and of geology, as a rich mine of carefully arranged facts, presenting in one connected series the proof of the vast influence of microscopic life throughout air, earth, and ocean. J. W. B.

10. *Exploration of the Red River of Louisiana in the year* 1852; by Randolph B. Marcy, Captain Fifth Infantry U. S. Army, assisted by George B. M'Clellan, Brevet Captain U. S. Engineers. 286 pp., 8vo, with numerous plates. *Washington*, 1854.—This is a valuable Report, both in its narrative part, which gives details of the country, and its scientific appendix. The party visited the Witchita mountains, which rise abruptly from the plains, and consist of granite, unlike the surrounding regions, and are intersected by quartz veins and dykes of greenstone. They are the only high mountains in the Red River Territory. Dr. Shumard, in his Geological appendix, gives an account of the carboniferous formation in northwestern Arkansas, and beyond, between Fort Smith and Fort Washita. At Fort Washita cretaceous strata commence, and continue on uninterrupted to the southwestern boundary of the Cross-Timbers in Texas. They extend in the direction of Fort Towson 100 miles, with an average breadth of 50 miles. The beds correspond to the upper part of the European chalk. They are often full of fossils, and at Fort Washita, ammonites were observed three feet in diameter.—Beyond the Witchita mountains, there were ranges of high bluffs which resembled fortifications in their even height and regularity; they consisted of layers of red and blue clay thickly interstratified with snow-white gypsum. Some masses of gypsum at their base were 10 feet in diameter. On the Red River,

from Cache Creek to Sweet Water Creek there are two *terraces*, besides the lower plains subject to inundation; the lower is 10 to 20 feet high; the other 50 to 100 feet.

The Appendix includes Reports on Minerals by Prof. C. U. Shepard; on Geology, by E. Hitchcock and G. G. Shumard; on the Palæontology, by B. F. Shumard; on Reptiles, by S. F. Baird and C. Girard, containing descriptions of new species, with many fine plates; on Shells, by Prof. C. B. Adams; on Orthopterous Insects, Arachnidians, Myriapods, by Charles Girard; on Botany, with several plates, by Dr. John Torrey; on Ethnology, by Capt. Marcy, and Prof. Turner.

11. *Annual Report on the Geological Survey of the State of Wisconsin;* by JAMES G. PERCIVAL. 102 pp. 8vo. Madison, Wisconsin, 1855.—Dr. Percival entered upon his duties as Geologist of the State of Wisconsin in August, 1854, and the season therefore was already so far advanced, tha at complete preliminary reconnoissance even of the mineral district was hardly possible. The Report still shows much labor. The rock strata of the lead region are described; and considerable information of value is given respecting the lead mines. Dr. Percival appears to be inclined to the view, not hitherto admitted, that the lead occurs in veins, instead of deposits or beds, which veins may be traced far below the recognised lead-bearing rocks. We shall look with interest for facts on this important point which the progress of the Survey may bring out, deferring for the present an extended notice of the subject.

12. *First Annual Report of the Geological Survey of the State of New Jersey for the year* 1854. 100 pp., 8vo. *New Brunswick*, 1855. —This Report embraces Reports by WM. KITCHELL, the Superintendent on the northern section of the State, Prof. G. H. COOK, assistant Geologist, on the southern section, HENRY WURTZ, Chemist, and EGBERT S. VIELE, Topographical Engineer. The observations presented in this Preliminary Report, are principally of a practical character and relate to the marls and beds of ore.

Mr. Cook recognises in the cretaceous strata, three distinct beds of greensand marl, alternating with strata of sand; the lower marl bed is about 30 feet thick, and contains as fossils, *Exogyra costata*, *Gryphæa convexa*, *Ostrea falcata*, *Terebratula Sayii*, *Belemnites Americanus*, etc. The second and third marl beds are each near 50 feet thick. The second contains Gryphæa convexa, and at one place vast numbers of Terebratula Harlani, with other species. In the third bed, fossils are rare, and appear to differ in species from those below.

13. *Geological Survey of Canada; Report of Progress for the year* 1852–53. Printed by order of the Legislative Assembly. 180 pp., 8vo. *Quebec*, 1854.—No Geological Survey on this continent has been carried on with more thoroughness and with results of higher importance to the science than those of Canada under the direction of Mr. W. E. Logan. There is great precision in his observations, and exactness in his statements; and it will be a work of great honor to Canada when the Survey is throughout completed, and the Final Report, fully illustrated with plates of fossils and sections, is published. Much more time will yet be needed before this can be satisfactorily done. All the observations bear directly on the geology of the United States, and they have already solved several doubtful points as to the age of American rocks.

III. Botany and Zoology.

1. *Dr. Hooker's Flora of New Zealand.* Parts 7 and 8, 1855, complete this excellent Flora, in 2 quarto volumes, with 130 colored plates. Both these parts are devoted to the lower Cryptogamia, namely, the conclusion of the *Hepaticæ*, by Mr. Mitten; the *Fungi*, by Mr. Berkeley; the *Algæ*, by Dr. Harvey; and the *Lichenes*, by Mr. C. Babington. Dr. Hooker has added an analytical key to the natural orders represented in the flora, and another key to the genera, adapted to the Linnæan method. Also a Catalogue of European and other plants introduced into New Zealand; and a Supplement, of some recent additions and corrections, manifesting the authors scrupulous care and indefatigable activity to the last. We notice with interest the statement that the small order of *Monimiaceæ* "should be transferred to the neighborhood of *Magnoliaceæ*, to which it is closely allied, whereas it has no real affinity with *Laurineæ*." We hope soon to have to speak of Dr. Hooker's labors upon a different field, namely, the Indian flora. A. G.

2. *Seemann's Botany of the Voyage of the Herald.* Part 6, (1854, pp. 201–253, tab. 51–60,) brings to a conclusion the flora of the Isthmus of Panama. As usual, the author introduces new observations here and there upon the botanical history and economical uses of important plants, or their products; and the present fasciculus is more than usually rich in this respect. The first relates to the famous Panama hats, made from the leaves of *Carludovica palmata*, a Pandaneous plant.

"The *Jipajipa* or *Panama hats* are principally manufactured in Veraguas and Western Panama: not all, however, known in commerce by that name are plaited in the Isthmus; by far the greater portion is made in Manta, Monte Christi, and other parts of Ecuador. The hats are worn almost in the whole American Continent and the West Indies, and would probably be equally used in Europe, did not their high price, amounting often to 150 dollars for a single one, prevent their importation. They are distinguished from all others by consisting of only a single piece, and by their lightness and flexibility: they may be rolled up and put into the pocket without injury. In the rainy season they are apt to get black; but, by washing them with soap and water, besmearing them with lime-juice or any other acid, and exposing them to the sun, their whiteness is easily restored. So little is known about these hats, that it may not be deemed out of place to insert here a notice of their manufacture. The straw (Paja), previous to plaiting, has to go through several processes. The leaves are gathered before they unfold, all their ribs and coarser veins removed, and the rest, without being separated from the base of the leaf, is reduced to shreds. After having been put in the sun for a day, and tied into a knot, the straw is immersed in boiling water until it becomes white. It is then hung up in a shady place, and subsequently bleached for 2 or 3 days. The straw is now ready for use, and in this state is sent to different places, especially to Peru; where the Indians manufacture from it, besides hats, those beautiful cigar-cases, which fetch sometimes more than £6 a piece. The plaiting of the hats is done on a block, which is placed upon the knees; it commences at the crown and finishes at the brim. According to the quality of the hats, more or less time is occupied in their completion; the coarser ones may be finished in two or three days; the finest take as many months. The best times for plaiting are the morning hours and the rainy season when the air is moist: in the middle of the day and in dry clear weather the straw is apt to break, which when the hats are finished is betrayed by knots, and much diminishes their value."—p. 204.

Vegetable Ivory.—This consists of the seeds of the *Phytelephas macrocarpa;* a palm-like plant, but not, it appears, a member of the family of Palms. It is now taken as the typé of a separate group, more closely allied to the *Aroideæ* than to the *Palmeæ.* Seemann incorporates into his account the whole history of our knowledge of the tree and its useful product, from its discovery by Ruiz and Pavon down to his own personal observations, which have enabled him to complete the botanical characters, &c., and has introduced a translation of Morren's account of a microscopical investigation of the structure of the *ivory;*—of which we give a condensed abstract:

Passing by the tegumentary portion, "the albumen, or vegetable ivory itself is composed of concentric layers of a white substance, thin portions of which are transparent in water and perforated with an infinity of holes, the sections of so many cavities. The latter are irregularly rounded, and also prolonged into arms or tubes, which give a starry appearance to the cavities, many of them being 5–10-rayed. Here and there may be seen a little spheroidal cavity; finally the tubes appear to be each of them tipped with a small swollen head. Throughout the albumen this structure is more or less regular, offering a beautiful study to the vegetable anatomist. Generally the starry cavities are arranged in a quincunx, so that the interval between two of them corresponds to a third. A little attention enables the observer to see that those rays which are terminated by a little head always answer to one another. * * It is evident that these starry cavities represent so many cavities of cells, which still preserve their radii of communication, though the primitive parieties are obliterated. * * * Thus we see revealed the whole organization of vegetable ivory, which is merely a prismemchyme with thickened cells, in which the rays of communication are preserved. This substance is very analogous to that which Schleiden and Theodore Vogel found in the albumen of the date, only that in the latter there is no starry disposition of the tubes, and the hollows of the cells are elongated into only 2 or at most 3 radii of communication." This ivory, as Morren observes, is nothing but the albumen of the seed, which at first milky, then pulpy, then of the fleshy consistence of an almond, becomes at length hard, white, and elastic nearly as ivory itself. Solid as it is, in the germination it reverts to the pulpy and milky condition (as was seen by Hooker in the stoves of Kew Gardens), and nourishes the forming embryo just like the albumen of an ordinary seed. In its native country the still soft young seeds are greedily eaten by bears, hogs and turkeys; and in the earlier fluid state it forms a delicious beverage.

"The *Pine-apple* was among the first plants which Columbus met with, on landing in northern Veraguas, where it was extensively used by the Indians. It may have been brought to the country at a very early period of history; but the fact that it was met with in the Isthmus on the arrival of the first European, together with the circumstance that it grows to all appearance wild in various parts of the country, may be looked upon as almost conclusive of its being indigenous."—p. 216.

Sarsaparilla.—Seemann appears clearly to have proved that *Smilax officinalis*, H. H. K., *S. papyracea*, Duhamel, and *S. medica*, Schlecht.—all yielding officinal sarsaparilla,—are botanically one and the same species. It grows on the slopes of mountains, to an elevation of 5000 feet above the level of the sea, in South America, between the 20th degree of north, and the 6th degree of south latitude, and the 110th and 40th degress of west longitude. The "Jamaica sarsaparilla," it appears, is not the produce of that island, but is received there from the Spanish Main, and thence shipped to Europe and the United States. The "Lisbon or Brazilian sarsaparilla" is distinguished from the former by pharmacologists chiefly by having fewer rootlets or "beards;" but it is evident that the rootlets have been removed by some rough mechanical process, as the marks of their origin are plainly seen; "proving that the roots when gathered had as much beard as the sort usually received as Jamaica sarsaparilla, and making it probable, that, if the merchant buying up this *Zarza* in various parts of Brazil, were to inform the collectors that by preserving the beard they would not only save themselves much unnecessary trouble, but increase the weight and the commercial value of the roots they dig up, we should soon get all our Jamaica sarsaparilla from Brazil, and in a few years have difficulty in obtaining even a specimen of what is now termed Lisbon sarsaparilla." As to another chief distinction of the pharmacologists, into the mealy and non-mealy sorts; "any body opening a bundle of Jamaica sarsaparilla may pick out as many roots as he chooses, mealy at one end and non-mealy at the other." As to the distinctions of the form of the cells of the 'liber,' which have been considered by physiologists as forming good marks of distinction between the sarsaparillas of Central America and those of South America, our author cites from a paper by Mr. Bentley, in the Pharmaceutical Journal for April, 1833, the results of recent microscopical examinations which invalidate these characters also.

The rather few *Gramineæ* and *Cyperaceæ* of the Isthmus are elaborated by the venerable Nees von Esenbeck, and this is announced as probably the last scientific labor of a career as an author which began about forty years ago. The *Ferns*, here numerous in species, are elaborated by Mr. Smith of Kew, who has introduced and explained the characters discovered and turned to important account by him in classification, founded on the structure and mode of development of the caudex and fronds. In a note, Mr. Smith gives further information about the *Lomaria eriopus* of Kunze, or *Stangeria paradoxa*, which proves to be a true Cycadaceous plant, "presenting a new feature in that order on account of its simply forked venation rising from a true midrib, thus rendering untenable the character which is usually relied upon for distinguishing fossil *Cycadeæ* from fossil *Filices.*" !

From the plates in this part belonging to the Flora of Northwestern Mexico, we perceive that Schultz intends to keep *Acourtia* distinct from *Perezia*. A. G.

3. *Tulasne, on the Uredineæ and Ustilagineæ.*—Nearly two numbers (2 and 3) of the second volume of the botanical portion of the *Annales des Sciences Naturelles* for 1854, are occupied with Tulasne's elaborate "*second Mémoire sur les Uredinées et les Ustilaginees,* which are those microscopic Fungi that attack and inhabit living plants (foliage, herbaceous and even woody stems, immature fruits, &c.), some of which, known to us by the name of Rust, Blight, and the like, often do a vast deal of damage. As an instance we may allude to the malady of the grape, which for the last year or two has so seriously diminished the product of this important culture in the south of Europe, Madeira, &c. This memoir, like its predecessor (in 1847), is not of a popular character, and scarcely touches directly upon the subject of these ravages; but is a profound scientific investigation, of the highest order, into the structure, development, mode of life, and kinds of this minute parasitic vegetation, upon a clear and true knowledge of which all successful remedial or preventive measures will have to be based. As Fungi, even of these tribes, are beginning to be studied in this country with much zeal, we have only to call the attention of our mycologists to this able paper, and to say that the general physiologist will also find it of no small interest, from the light it sheds upon some of the simplest forms of vegetable existence. M. Tulasne devotes much attention to a curious complication which occurs in these otherwise so simple plants; the lowest organized forms being almost uniformly intimately associated with those of a different and higher organization. This has been variously explained; some supposing one kind to change into the other associated with it by a further development; some have contended that one species was here parasitic upon another, itself a parasite; while others look upon these cases as a kind of dimorphism in fructification, comparable with what is known to occur in a good many Phænogamous plants. The latter view is maintained by M. Tulasne, and its correctness is nearly demonstrated. A. G.

4. *The Grasses of Wisconsin and the adjacent States;* by I. A. Lapham, Milwaukie: in the *Transactions of the Wisconsin State Agricultural Society*, vol. iii, for 1853. Madison, 1854.—Both as to the matter which they contain and the manner in which they are edited and printed, the 'Agricultural Transactions' of the young State of Wisconsin compare most favorably with those of any of the older States. The communications which make up a large part of the present volume are of a better, more correctly scientific, and truly practical character than those which we generally meet with in such publications, where the amount of *chaff* is apt to be grossly disproportionate to the grain. We are much struck with the amount of learning and the general scientific accuracy, as well as the practical good sense of those we have particularly examined; such as the articles on the Potato, and its disease, by R. W. Wright of Waukesha, and on Vegetable Physiology as applied to Farm Plants, by J. Townnly of Moundville. At the close of the volume nearly 100 pages are occupied by Mr. Lapham's faithful and excellent account of the grasses of Wisconsin, prefaced by a general account of the family, and a convenient artificial arrangement or key to the genera of the Grasses of the Northwestern States. The species are well described in plain botanical language, their qualities and uses

indicated, good 8vo plates of eleven species are given, each accompanied by magnified analyses of the parts of fructification, and similar analyses of as many more species are given on another plate. These are creditably executed from original drawings by Mr. Lapham himself, and they will afford invaluable assistance to the student of this difficult but very important natural order of plants,—most important to the agriculturist since it furnishes the principal sustenance of man and the domesticated animals. A. G.

5. *H. G. Reichenbach: De Pollinis Orchidearum Genesi ac Structura, et de Orchideis in artem ac Systema redigendis.* Leipsic, 1852, pp. 38, 4to. tab. 2.—We ought earlier to have noticed this elaborate essay of the younger Reichenbach, who is devoting himself to the study and systematic arrangement of the great Orchideous family with much ability and acuteness, as this and other recent publications show. The formation and development of the various and singular forms of pollen in this family are fully and beautifully illustrated, both in the letter-press and in the figures, which last fill two crowded plates. Of their bearing upon the systematic arrangement of *Orchideæ* we are not qualified to judge: but it is highly in their favor that they appear to coincide with the views long ago propounded by Robert Brown. A. G.

Ergot, of Rye and other Grasses, is produced by species of *Claviceps*, a genus of Ascomycetous Fungi established by Tulasne, who has cleared up the great confusion which prevailed respecting the nature and history of these vegetables, or vegetable productions. The ergot is not a metamorphosed seed resulting from diseased conditions, nor a mere diseased form of the seed associated with a parasitic fungus, as thought by E. Quekett, Leveillé, Phœbus, Mougeout, and Fée, but a real fungoid structure. The first sign of the attack of the fungus upon the flower of a grass is the appearance of the *sphacelium* upon the outside of the nascent pistil; it soon penetrates the wall of the ovary, growing with it until it forms a fungoid mass of the same shape as an ovary, but obliterating the cavity of the latter. At this time it is soft, while, grooved on the surface, and excavated by irregular cavities, which are connected with the external folds or grooves: the surfaces of these are all covered with parallel linear cells, like a hymenium; and from the extremities of these arise elongated, ellipsoid, or oval cells, about 1-5000″ in length. These become detached, and when placed in water germinate and emit filaments. These bodies are *spermatia*, *stylospores*, or perhaps *conidia*. At a certain epoch a viscid fluid exudes from the sphacelium, flowing over it and carrying about multitudes of the *spermatia* or *stylospores;* but previously to this, a solid body, of a violet color on the surface and white within, has originated at the base of the *spermagonium*, and it gradually grows and rises out of the paleæ of the flower, forming the spur or *ergot*. Three species are described by Tulasne.—(*Micrographic Dictionary*, by *Griffith and Henfrey*, part 6.) A. G.

6. *Trigonocarpon.*—Mr. Jos. D. Hooker has shown, from the structure and integuments, that the fossil fruit of the coal era called Trigonocarpon, is the fruit of a coniferous tree, and is near that of the genus Salisburia.—*Roy. Soc., London, March*, 1854.

7. *Analytical Class-Book of Botany, designed for Academies and Private Students.* In two parts. Part 1, Elements of Vegetable Struc-

ture and Physiology; by FRANCES H. GREEN; Part II, Systematic Botany, illustrated by a Compendious Flora of the Northern States; by JOSEPH W. CONGDON. 328 pp., small 4to. *New York*, 1855. D. Appleton and Co.—An elementary and well illustrated text-book for the young student of Botany.

8. *On Bathygnathus borealis, an extinct Saurian of the New Red Sandstone of Prince Edward's Island;* by JOSEPH LEIDY, M.D., (extracted from the Journal of the Acad. of Nat. Sci. Philad., vol. ii.)—In the last visit of the enthusiastic and distinguished geologist Sir Charles Lyell, to this country, he informed me that Mr. J. W. Dawson of Pictou, Nova Scotia, had received from Mr. D. McLeod, for disposal, a fragment of a jaw of a large saurian animal, which was found in the New Red Sandstone Formation of Prince Edward's Island. Mr. Lyell sent me an outline drawing of the jaw: and with the disinterestedness of a cosmopolite philosopher, recommended Mr. Dawson to send the specimen to the Academy of Natural Sciences of Philadelphia, in preference to disposing of it abroad. It was accordingly sent to the latter place, and was purchased by Messrs. Isaac Lea, William S. Vaux, and myself, and was presented to the Academy, in the cabinet of which it is now very appropriately arranged at the side of the only other known saurian bones discovered in the New Red Sandstone of North America, described by Mr. Lea, under the name of *Clepsysaurus Pennsylvanicus.*

The specimen consists of the right dental bone, considerably broken, attached by its inner surface to a mass of matrix of a red granular sandstone, with large, soft, angular, red chalk-like stones imbedded in it. The fossil has seven large teeth protruding beyond the alveolar margin of the jaw; and it is hard, brittle, and cream-colored, and stands out in beautiful relief from its dark red matrix. The jaw indicates a lacertian reptile, and in comparison with that of other known extinct and recent genera is remarkable for its great depth in relation to its length.

The depth of the dental bone below the contiguous pair of equal sized teeth is five inches, whilst its length in the perfect condition appears not to have been more than seven and a quarter inches; for in the specimen the middle part of the posterior border is so thin and scale like, that I am disposed to think it here came in contact with the supra-angular and other neighboring bones.

The outer side of the jaw is vertical, and over the course of the alveolar parapet is plane; but below this posteriorly and inferiorly above, the base of the bone is depressed into a moderately deep concavity. The upper or alveolar border forms a convex line rapidly descending towards the chin. The base forms an oblique line, and ascends anteriorly to the chin; and it appears thick and rounded externally; but in the specimen it presents an abrupt border internally, as if the inner side of the bone had been broken away, or as if the angular bone had articulated with it much in advance of its usual position in saurians.

The external surface of the dental bone is every where marked by fine, reticular, vascular grooves, and in the vicinity of the alveolar border it presents numerous minute vasculo-neural foramina.

There is no regular row of foramina, visible in the specimen, for the transmission of terminal branches of the inferior dental nerve, such as exists in the Iguanas, Varanians, etc., but near the point of the chin there is a relatively very large foramen, partially filled with matrix, which appears to correspond with the internal mental foramen of the *Iguana.* Just posterior to this foramen there is a deep vascular groove, which in the perfect condition of the specimen may have proceeded from another foramen.

The teeth in their relation to the dental bone, are placed upon the inner side, and rest against the alveolar border, which rises in a parapet external to them. Whether the parapet is supported by abutments between the teeth, as in *Megalosaurus*, I cannot certainly ascertain from the inner side of the jaw being so closely adherent to the matrix. The dental bone, if it be considered complete in its length in the specimen, is capable of containing a series of twelve teeth posterior to and including that situated most anteriorly in the fossil.

As the teeth were worn away or broken off, they were replaced by others produced at their inner side, as is indicated in the specimen by a young tooth, which is situated internal to, and is concealed by, the largest mature tooth.

The enameled crowns of the fully protruded teeth are exserted at their base for several lines above the alveolar border of the jaw. They are compressed, conoidal, and recurved, but compared with those of *Megalosaurus* they are not so broad, compressed, nor recurved, and they are more convex externally, and are less so internally. They resemble much in form those of the recent *Monitor ornatus*, but are less convex internally.

The transverse section of the crowns of the teeth, except that of the first, is antero-posteriorly elliptical, with the inner side less convex and the extremities acute and in most instances slightly incurved.

The anterior and posterior acute margins of the crowns are minutely crenulated; and the crenulations commence just below the tip and descend as far as the enamelled base.

In comparison with the teeth of *Clepsysaurus Pennsylvanicus*, those of the fossil under examination are broader and more compressed, and except the first one of the series, present an acute, crenulated margin anteriorly and posteriorly, whilst in the former animal they are acute and crenulate only posteriorly.—[We omit part of the details.]

From the extraordinary relative depth of the dental bone above described to its length, and from its northern locality, I have proposed for the carnivorous lacertian to which it belonged the name of *Bathygnathus borealis.**

This interesting fossil is the second authentic discovery of saurian bones in the New Red Sandstone Formation of North America; the first being those found near Hassac's Creek, in Lehigh Co., Pennsylvania, by Dr. Joel Y. Shelley, and described by my friend Mr. Isaac Lea, under the name of *Clepsysaurus Pennsylvanicus.*†

In relation to the exact locality and geological position of the *Bathygnathus borealis*, Mr. J. W. Dawson has furnished me with the following note.

"The fossil was found at New London, on the northern side of the Island, imbedded to the depth of nine feet in red sandstone, with calcareous cement, similar to the matrix attached to the fossil. The total

* Proc. Acad. Nat. Sci., vi, 404. † Ibid, v., 171, 205; Jour. Ac. Nat Sci., ii.

depth from the surface was 21 feet 9 inches, and the discovery was made by Mr. D. McLeod of French river, New London, when digging a well.

"The sandstone in question belongs to a formation which occupies nearly the whole of Prince Edward Island, generally dipping at a small angle to the northward. It includes thin beds of coarse, concretionary limestone, and at the southern side of the Island, where the oldest beds of a formation appear, there are beds of gray clay or soft shale, and brown and gray sandstone, approaching in aspect to the upper beds of the coal formation of Nova Scotia, and containing silicified trunks of *coniferous trees*, with indistinct vegetable impressions, perhaps *calamites.* These beds may either belong to the top of the carboniferous system, or to an overlying deposit of the Permian or Triassic age; and in either case the red sandstones which conformably overlie them will be equivalent to the New Red of western Nova Scotia and Connecticut, and probably Triassic or Permian. The present specimen is the first animal fossil hitherto discovered in these sandstones, (of Nova Scotia,) which must, however, be distinguished from the *Lower carboniferous Red Sandstones* of some parts of Nova Scotia, associated with gypsum and marine limestones, which were formerly confounded with the New Red. See Letter by the writer in Proc. of Ac. Nat. Sci. Philad., iii., 272; and Papers in Journal of London Geological Society, iv, 50."

This paper is illustrated by a fine plate.

IV. Astronomy.

1. *Elements of Polymnia*, (33) (Compt. Rend., t. 39, p. 1019).—The elements of this planet given below were computed by Mr. Bruhns from the observations at Paris, Oct. 28, and at Berlin, Nov. 3 and 9.

Epoch 1854, Nov. 0·0 M. T. Berlin.

Mean anomaly,	10° 26′ 8″ ·5	
Long. perihelion,	22 25 58 ·4	Mn. Eqnx.
" asc. node,	1 12 29 ·2	1855·0.
Inclination,	1 22 20 ·6	
Angle of excentricity,	12 58 2 ·1	
Mean daily motion,	967″·235	
Log. semi-axis major,	0·376356	

2. *Elements of Amphitrite*, (29) (Comptes Rend., t. 39, p. 1060.)—Mr. Yvon Villarceau has computed a set of elements of this planet making use of all the observations collected during its appearance.

Epoch 1854, March 0·0 M. T. Paris.

Mean anomaly,	123° 51′ 0″·85	
Long. perihelion,	56 52 31 ·26	Mn. Eqnx.
" asc. node,	356 23 55 ·19	March 0·0
Inclination,	6 7 41 ·08	
Angle (sin = excen.),	4 16 31 ·76	
Mean daily motion,	869″·48241	
Semi-axis major,	2·5536647	
Period of sideral revolution,	4·yrs080810	

By means of these elements an ephemeris has been computed for this planet and published in the *Compt. Rend.*, tome 40, p. 244.

3. *Comet* III, 1854, (Compt. Rend., t. 40, p. 199).—The parabolic elements of this comet given below were computed by Mr. Santini by means of Argelander's observation of June 11, and those of the author of June 26 and July 10.

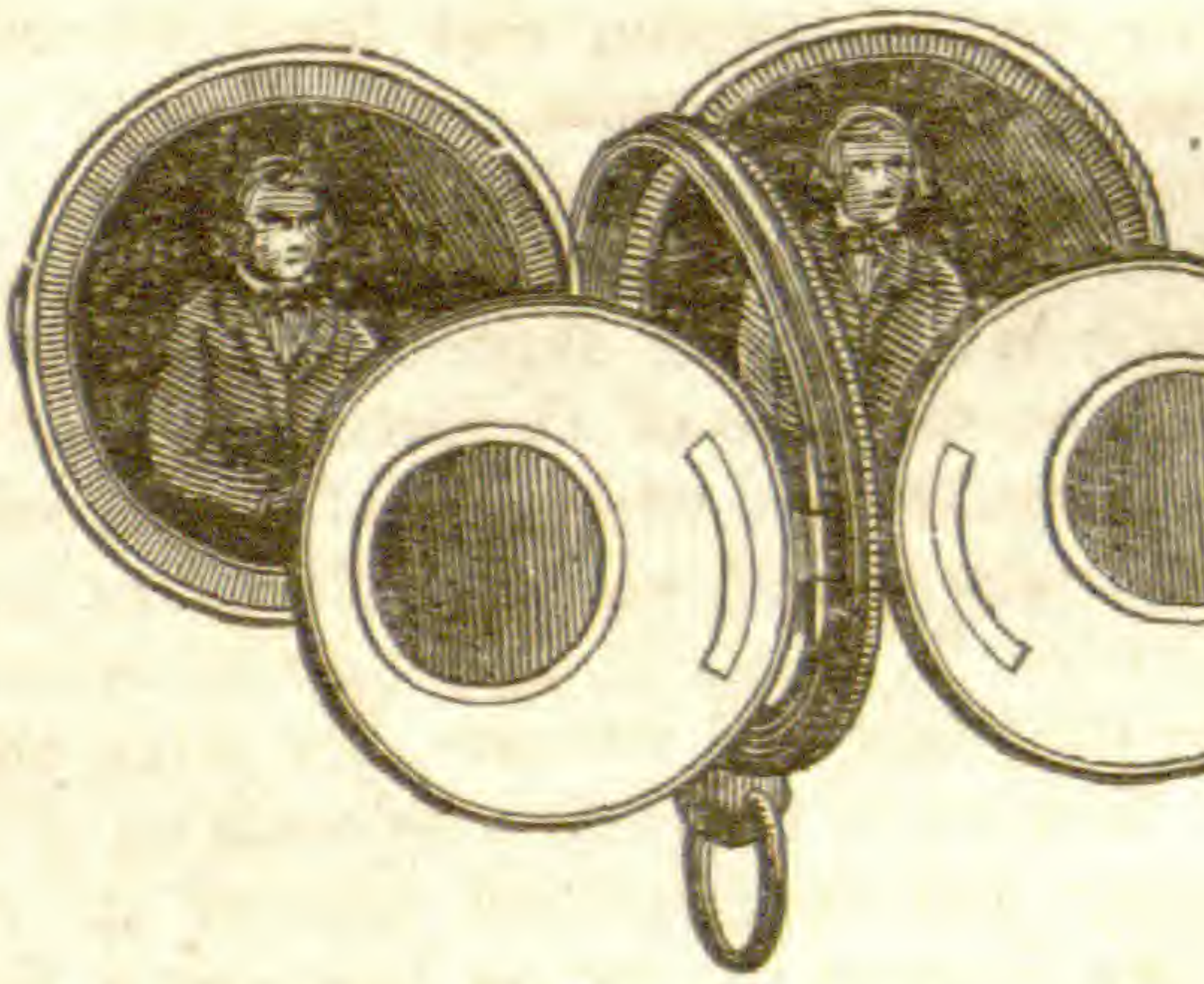
Perihelion passage 1854, 173^{d}03264 M. T. Berlin.

Long. perihelion, - - -	62° 13′ 35″ ·9	Mn. eqnx. 1854 Jan. 0·0
" asc. node, - - - -	347 39 36 ·3	
Inclination, - - - -	108 41 0 ·4	
Log. perihelion dist., - - -	9·811640	

4. *New Comet*, (Compt. Rend., t. 40, p. 200).—A new comet was discovered Jan. 14, by Mr. Dien, an assistant in the Imperial Observatory at Paris, and by Mr. Winnecke at Berlin, in the neighborhood of γ Scorpionis. Its position Jan. 15, 18^{h} 4^{m} 16^{s}, was R. A. 226° 5′ 15″ and Dec. −27° 15′ 5″. Its apparent motion in 24 hours was R. A. +45′ and Dec. −4′.

V. Miscellaneous Intelligence.

1. *Mascher's Stereoscopes.*—The annexed figure is a perspective view of a very ingenious application of the stereoscope to daguerreotype medallions. A patent for this improvement has been recently



granted to J. F. Mascher of Philadelphia. Attached to the main central rim of a locket, there are two lids with daguerreotype pictures on them; these lids are hinged on each side of the rim. There are also two supplementary lids, each containing a lens, which are also hinged to the rim as shown, but are fitted to fold within the picture lids, and are arranged in such relation to the same, that upon being opened and properly adjusted, the lenses will stand opposite to the pictures, and convert the medallion into a stereoscope, by which a person looking through the glasses, will see but one picture, solid and life-like. The patentee has applied double convex lenses to these medallions—the sides of which are of unequal convexity (as one to six)—according to Brewster, so that the picture is rendered very clear. A medallion of this character can be used for a microscope and sun glass, and thus it can be carried around in the pocket, both as an ornamental and useful memento of affection.

More information may be obtained by letter addressed to J. F. Mascher, No. 408 North Second street, Philadelphia, Pa.—*Sci. Amer.*

2. *A wonderful specimen of credulous ignorance;—Fossil man aud woman.*—A Cincinnati paper of March 23, contains a narration of the discovery of some "very curious petrified human bodies" found in Pennsylvania in the bed of a stream, which is one of the branches of the Alleghany river. The account says: "These remains are supposed to be those of a man and woman, who by the wonderful petrifactive process have been turned to solid stone," and they are regarded as "irrefragible proofs of the existence of man upon this revolving globe long before the periods when corals, crinoids and trilobites first made their appearance." * * * But "the man is the great curiosity Its feet are now wanting; its body and legs are composed of sandstone, and its head of quartz and gneiss"! Thus, according to the narrator, the whole science of geology is upset, over and over. The writer continues, "It is assumed that when first found the feet were on this male petrifaction, but as they seemed slaty and of a coal-like texture, they were burned by the women, who prefer utility to scientific discovery." * * * "It is certain the man when alive must have inhabited the sandstone for a period, and if, as we think is evident, he was buried with his head downwards, and at just such a depth that his head came in the gneiss, and his body in the sandstone formation, [he might have added, his feet in a coal-bed], then it is easy to conclude that his body petrified into sandstone, and his head into quartz and gneiss." The believer in such nonsense is the most of a wonder.

3. OBITUARY.—*Notice of the late Frederic W. Davis of Boston.*—We have to record the death of one of our excellent practical chemists and metallurgists, FREDERIC W. DAVIS of Boston, who died at his father's house of typhoid fever on the 12th of December last, at the age of 31 years. Mr. Davis received a good education at the school of Mr. Green of Jamaica Plains in Roxbury, and was then placed under the scientific instruction of Dr. Charles T. Jackson, in whose laboratory he pursued his studies with great diligence and success, for three years. In 1844 he accompanied Dr. Jackson in his early explorations of the copper regions of Lake Superior and distinguished himself as an active and faithful explorer of the mineral district on Keweenaw Point. In 1847 he was appointed by the Revere Copper Company, as Superintendent of their copper smelting furnaces at Point Shirley, which he conducted with signal ability from that time, until he was seized with the fever of which he died. While attending to the active and complicated business of the copper works making all the assays of ores, fluxes, furnace slags, and of the crude copper produced, he found time to make many interesting and important metallurgical researches, and many scientific observations and experiments on the formation of artificial minerals, both in the furnace and in the roasting heaps of copper ores. He produced a new mineral, composed of the sulphurets of zinc and copper, which was found in brilliant black crystals in the roasted ores. He pointed out several new forms of crystals in the slags from his blast furnaces, and he also beautifully illustrated the theory of the formation of native copper from the vaporized chlorid of copper, while working the Atacamite of Peru.

The most important of his labors were of an eminently practical nature, such as discovering the best and most economical methods of mixing the various copper ores of commerce, so as to make one ore flux another, and thus to obtain the largest yield of metal at the least expense.

Science and the arts have met with a great loss in the death of this excellent young metallurgist, whose labors were calculated to render efficient services to mankind and to raise the business of the working furnace to the rank of a truly chemical art and science.

His numerous friends and acquaintances well knew his worth as a man, and a friend, always generous, considerate and kind, and never wanting in public spirit when occasion called him out, he was both respected and beloved by all who knew him. C. T. J.

Boston, February 17, 1855.

4. *The Physical Geography of the Sea;* by M. F. MAURY, L.L.D., Lieut. U. S. N. 274 pp. 8vo, with maps and plates. *New York*, 1855. Harper & Bros.—Lieut. Maury in this volume on the ocean, brings together under a popular form many of the results and discussions brought out in his Sailing Directions and other publications, and the work cannot fail to find many interested readers. The following are the subjects treated of: The Gulf Stream; The Atmosphere; Red Fogs and Sea Dust; On the Probable Relation between Magnetism and the Circulation of the Atmosphere; Currents of the Sea; The open Sea in the Arctic Ocean; The Salts of the Sea and the Influence of Molluscs and Corals on the Circulation of the Ocean; Equatorial Cloud-ring; Geological Agency of the Winds; Depth of the Ocean; Basin of the Atlantic; Winds; Climates of the Ocean; Drift of the Sea; Storms; Routes for Vessels. While the work contains much instruction, we cannot adopt some of its theories, believing them unsustained by facts.

5. *Report and Charts of the Cruise of the Dolphin: made under the direction of the Navy Department;* by Lieut. S. P. LEE, U. S. Navy. 332 pp., 8vo, with maps and plates. *Washington*, 1854.—This volume contains the sea observations made during a cruise in search of several shoals in the Atlantic Ocean. The sea and air temperatures are given with fullness and many other points of interest receive attention. The low island called Las Rocas, 84 miles due west of Fernando de Noronha, was found to be a *Coral Island*, having a regular lagoon. The reef is 1¼ miles from east to west and 1¾ from north to south, and is covered at high tide, with the exception of two small islets, Sand and Grass Islands, situated on the west side of the reef, and some scattered rocks on the other sides; these dry spots are 10 to 15 feet above the reef but are without wood or water. The reef is generally level, although with many holes in it. There is 1 to 4 feet water within the lagoon at low tide. A rocky bottom was found at 15 fathoms 6 miles east of the reef, but no bottom at 30 fathoms 2½ miles N. N. E., nor at 70 fathoms 4 miles S. W. of it.—The centre of this dangerous reef is in latitude 3° 51′ 27″ south, and longitude 33° 48′ 57″ west.

6. *Grammar and Dictionary of the Dacota Language*, edited by Rev. S. R. RIGGS, A.M.—This is one of the valuable series of volumes published by the Smithsonian Institution, and forms a learned addition to an important department of knowledge in which Americans should take the lead, because the materials are more accessible to them.

The grammar is carefully elaborated, and the etymological portions of the dictionary exhibit a thorough acquaintance with the language. Such works should be continued by the Institution and Indian Bureau, and would be very creditable if done as well as this. But there are several defects to which it is proper to call attention, that they may be avoided hereafter.

In the English-Dakota part the *accent* is not indicated, so that after finding a word here, we must turn to the first part to enable us to pronounce it, thus requiring an examination of two alphabets for one word.

This work is founded upon the labors of various missionaries for eighteen years; it received the approbation of the Minesota Historical Society, and the Board of Foreign Missions; and it was submitted to Professors W. W. Turner and C. C. Felton. Yet the explanation of one of the new characters " —denotes a nasal sound similar to the French *n* in *bon*, or the English *n* in *drink*." This renders the pronunciation of a large number of words doubtful, the French nasal, as in *bain*, ending with a vowel, has no affinity with English *bang*, ending with a consonant.

Judging from the cognate Konza it is probable that *both* these sounds occur in Dacōta. In the presence of such a fact, no dependence can be placed upon the comparisons with Arabic sounds, probably never heard; nor are the "emphatic" consonants described with sufficient minuteness. The relations and affinities of Dacōta with other American languages are not mentioned, although they are of the greatest importance.

The orthography is judicious, although perhaps open to improvement. Whilst philologists are endeavoring to ameliorate the orthography of foreign languages, Mr. Schoolcraft prefers an English basis, from which nothing but typographical abortions can result. For example, let us write an Indian word containing the English syllable *paw* followed by *h* in *hut*. This word will then stand "*pawh*" in English orthography. Another Indian word is composed of *ta* in *tart*, followed by *wh* in *when*, giving the English orthography, "*tawh*." Notwithstanding the apparent resemblance, *pawh* and *tawh* have not an element in common, their finals being as distinct as their initials. The fine art department of Mr. Schoolcraft's great work is also defective, a large sum having been spent in engraving the almost worthless sketches of Captain Eastman, instead of devoting it to ethnological illustrations of more value.

S. S. H.

7. *Fresnel's Wellenfläche; Axonometrical Projections of the most important Geometrical surfaces, Drawings of Descriptive Geometry*, serving in the same time as a Catalogue of Models carried out according to aforesaid Projections; by FERDINAND ENGEL, with 11 plates. Berlin.—By way of a notice of this able work, we give here in a condensed form the introductory remarks by F. Joachimstahl, Professor at the University of Halle.—The collections of models of Mr. Engel, and his drawings, are of special importance in the study of the higher Geometry and Optics and merit general attention. The model of the wave of light gave him most difficulty. Hitherto it had been thought sufficient in giving an idea of the surfaces with their two sheets, to represent the principal sections by means of wire. Mr. Engel was the first to

succeed in modelling the surfaces in wood. His model, as it is dissected, opens the exact form to inspection. The Jury of the World's Exhibition in London gave Mr. Engel the prize medal for this model, Sir David Brewster being the Chairman of the Jury and Sir John Herschel one of its members. Mr. Engel's models 3 to 12, represent the five principal classes of surfaces of the second order, with their circular sections, right lines and lines of curvature: numbers 13 to 20, represent cones, combinations of hyperbolical paraboloids, &c.; 21 to 27, several helicoids and screws; 28 to 30, three retilinear screw planes (not belonging to the family of surfaces just mentioned); 31, 32, two developable surfaces; 35 to 37, refer to the theory of spherical curves and their polar curves, etc. The drawings are made with great exactness. S. S. H.

8. *A Catalogue of British Fossils, comprising the Genera and Species hitherto described: with references to their Geological Distribution and the Localities in which they have been found;* by JOHN MORRIS, F.G.S. Second Edition, considerably enlarged. 8vo. *London*, 1854.—Mr. Morris's 'Catalogue' affords us the results of the numerous examinations of the fossils of the British Islands, both by native and foreign palæontologists. These researches, scattered through numerous works—periodical, monographic, and miscellaneous—were of limited value until brought within the reach of geologists in such a compendious form as the work now before us.

However well acquainted one may be with the bibliography and natural history of one or more groups of fossil creatures, whether bivalves, cephalopods, fishes, or any other,—and however readily he may exchange his knowledge with his fellow-workers in palæontology and give assistance to the practical geologist, yet, from the loss of time in hunting up references and figures of fossils,—the uncertainty of memory,—the mislaying of note-books, and a hundred other reasons, we well know that geological work cannot satisfactorily proceed without our having at hand a trustworthy book of reference to all described and figured species of organic remains.

Some ten years ago Mr. Morris produced such a work, thereby supplying the want then felt, and which the partial lists of fossils already compiled could not meet. Since 1843 geologists have extended their researches, both over new localities, and in parts of the organic kingdom previously but little studied; and an enormous increase of palæontological observations has been the result. That these observations should prove of their full value, it was high time that they should be reduced to order and brought to the test of strict comparison. With renewed energy and increased knowledge the author has again applied himself to the crowd of names and synonyms, and has now marshalled in alphabetical array, in their several classes, families, orders, and genera, upwards of 8300 species of British fossils.

In carrying out this arrangement the author submitted some sections of his works to those of his scientific friends who had respectively paid attention to the several groups of fossils; and the assistance rendered him in these departments the author freely acknowledges in the preface, where he assigns to each his due, and carefully notices the public and private collections from which he has gathered information and received assistance.

Many of the palæontographical notes and memoirs recently published, especially in the case of monographs, have done much to the correction of the nomenclature of the subject. Of these Mr. Morris has fully availed himself.—*Mag. Nat. Hist.*, xiv, 55.

9. *Fossils of South Carolina;* by M. TUOMEY and F. S. HOLMES, No. 1. 8 pp., 4to, with 2 4to lithographic plates. Charleston, S. C. 1855. John Russell.—It is especially gratifying to see the commencement of a work, under so good auspices and on so liberal a plan, on the Fossils of South Carolina. We wish it rapid progress towards completion, and abundant patronage. The number issued contains descriptions and figures of "Pleiocene" Fossils, including 2 corals, and 7 echinoderms. The plates are beautiful.

10. *A History of the British Marine Testaceous Mollusca*, distributed in their natural order on the basis of the organization of the animals, with references and notes on every British species; by WILLIAM CLARKE. 536 pp., 8vo. *London*, 1855. John Van Voorst.—The author of this work describes the characters and habits af the animals at considerable length, and partly as a result of original observations. The volume has therefore an importance beyond the limits of the country of which it treats.

11. *The Chemistry of Common Life;* by JAS. F. W. JOHNSTON, M.A., F.R.S., F.G.S., &c. Nos. iv and v, The Narcotics we indulge in; The Poisons we select; The Odors we enjoy; The Smells we dislike; What we Breathe and Breathe for; What, how, and why we Digest. In a former notice of this work, we expressed our opinion of its scientific ability and the popular interest thrown into every subject discussed. The author argues against the use of opium like one who personally valued the indulgence.

12. *The Year Book of Facts in Science and Art*, for 1854; exhibiting the most important discoveries and improvements of the past year, in Mechanics and the Useful Arts, Natural Philosophy, Electricity, Chemistry, Zoology and Botany, Geology and Geography, Meteorology and Astronomy; by JOHN TIMBS, F.S.A., Editor of "The Arcana of Science and Art" and author of Curiosities of London. 288 pp., 12mo. *London*, 1855. David Bogue.—The frontispiece of this useful annual, is a portrait of G. B. Airy, the Astronomer Royal.

13. *A Complete Treatise on Fish-breeding, including the Reports on the subject made to the French Academy, and the French Government;* and Particulars of the Discovery as pursued in England. Translated and edited by W. H. FRY. 188 pp., 12mo, illustrated with engravings. *New York*, 1854. D. Appleton & Co.—Artificial Fish-breeding has already been undertaken in several parts of the country, and carried on with great success. This work is most opportune, and is just the thing needed to spread a knowledge of this important subject over the land. It is popular in style and full in its details.

14. *On Adipocire and its Formation;* by C. M. WETHERILL, M.D. —From the Transactions of the American Philosophical Society, vol. xi. 25 pp., 4to. *Philadelphia*, 1855.—This valuable paper contains the results of both chemical and microscopic examinations of adipocire, and also an account of experiments upon the decomposition of muscular fibre (bullock's heart) with water, with a view to the formation of adipocire.

15. *An Essay on the Contagious character of Malignant Cholera*, with brief instructions for its Prevention and Cure; by BERNARD M. BYRNE, M.D., Surgeon U. S. Army. 2nd edit., with additionl notes by the author. 160 pp., 8vo. *Philadelphia*, 1855. Childs & Petersen.

16. *The World a Workshop, or the Physical relationship of Man to the Earth;* by THOS. EWBANK, author of "Hydraulics and Mechanics." 198 pp., 12mo. *New York*, 1855. D. Appleton & Co.—This work is written for working men, and to them dedicated "as a testimony of respect to the dignity and omnipotence of enlightened labor." It presents a view of nature mainly from the utility side, and at the same time is characterised by a high moral tone.

17. *The Florist and Horticultural Journal*, a monthly magazine of Horticulture, Agriculture, Botany, Agricultural Chemistry, Entomology, etc. H. C. HANSON, Editor. Philadelphia, vol. iv, No. 1, Jan., 1855. —Each number of this Horticultural Journal contains 32 pages 8vo, and is illustrated by one or more colored plates. The following persons are announced as among the contributors: John Le Conte, Esq., Profs. J. P. Kirtland, R. E. Rogers, S. S. Haldeman, W. B. Rogers, with John Cassin, W. D. Brackenridge, &c.

18. *Seventh Annual Report of the Regents of the University* of the State of New York, on the Condition of the State Cabinet of Natural History, and the Historical and Antiquarian Collections, annexed thereto. Made to the Senate, Jan. 18, 1854. 124 pp., 8vo. *Albany*, 1854.— This Report contains a valuable appendix on the Serpents of New York, by SPENCER F. BAIRD, illustrated by upwards of 30 figures on two plates.

19. *Handbuch der krystallographischen Chemie*, von C. F. RAMMELSBERG. 410 pp., 8vo, with 401 wood-cuts.—Prof. Rammelsberg has here issued an excellent work on the crystallization of various chemical products, giving figures of most of the forms, and the angles in full.

20. ALEXIS PERREY: Note sur les Tremblements de Terre ressentis en 1853, (From Bulletin of the Acad. Roy. Belg. xxi, No. 6).—Note, ibid., with Supplements pour les années antérieurs. Mem. de l'Acad. de Dijon, 1854.

—— Documents relatifs aux Tremblements de Terre au Chili, 208 pp., large 8vo. Présentés à la Soc. Imp. d'Agriculture, d'Hist. Nat. et des Arts utiles de Lyon, dans la Séance du 3 Mars, 1854.—A very complete and valuable collection of the various accounts of eathquakes in Chili.

21. E. DESOR: Une Dernière Ascension, (Extrait de la Revue Suisse de Janvier, 1854) 25 pp., 8vo. *Neufchatel*, 1854.—On an ascension of the Galenstock in the Alps in 1845.

—— Du climat des Etats Unis, et de ses effets sur les habitudes et les mœurs; (Extr. des Actes de la Soc. Helv. des Sci. Nat. session de 1853 à Porrentruy.)

—— Notice sur les Échinides du Terrain nummulitique des alpes, avec les diagnoses de plusieurs espèces et genres nouveaux. (Extr. des Actes Soc. Helv., &c. Session de 1853.)—These nummulitic beds are stated to have close affinity with the Calcaire grossier of Paris, in their Echinidæ, and not with the lowest Tertiary or Suessonian of D'Orbigny.

E. Desor: Les Cascades du Niagara, et leur Marche rétrograde, avec une carte et une coupe géologique (Extr. des Bulletin Soc. Sci. Nat. Neuchatel, tome iii.)—M. Desor, in his interesting memoir, concludes that the Falls of Niagara recede at a rate nearer 3 feet per century than 3 feet a year. He also argues that, in consequence of the position of the shale below, the height of the falls will increase, as they recede, so as to be much higher after receding two miles than now. The dip of the rocks to the south is stated at 0° 17′ or 25 feet to the mile, near the Queenstown heights, or 0° 10′, or 15 feet to the mile, from the present position of the falls to Lake Erie.

Proceedings of the Boston Soc. Nat. Hist., vol. v, 1855.—p. 81, Remarks on the Embiotocidæ; *C. Girard.*—p. 82, On some points in the osteology of the Mastodon and Fossil Elephant; *Sir J. Richardson.*—p. 84, Remarks on Batrachian footprints; *J. Wyman.*—p. 88, On Arenicola natalis; *C. Girard.*—p. 90, Parasitic plant destructive to house fly; *J. Wyman.*—p. 92, Note on the chemical composition of the scales of the Gar Pike; *C. T. Jackson.*—p. 94, New Species of Californian Fishes; *W. O. Ayres.*—p. 103, On American Hydras; *W. O. Ayres.*—p. 108, On the Orange Insect; *W. I. Burnett.*—p. 110, On some marine invertebrates inhabiting the shores of S. Carolina; *W. Stimpson.*—p. 118, Notes on the Wild Hybrid Duck; *Cabot.*—p. 120, Analysis of Allophane from Tennessee; *C. T. Jackson.*—p. 120, Note on the effects of locality, temperature, &c., on the forms of shells; *J. Lewis.*—p. 122, Remarks on the Cyclas and Lynnea; *J. Lewis.*—p. 125, Note on the manner in which birds retain their position in roosting; *J. Wyman.*—p. 126, Brief notes on some deep dredgings off the coast of Georgia, and Florida, by the Coast Survey; *A. A. Gould.*—p. 127, New species of land and freshwater shells from Western N. America; *A. A. Gould.*—p. 133, On the number of Teeth of the Mastodon giganteus; *I. A. Lapham.*—p. 136, Observations on A. Perrey's theory of Earthquakes.—p. 144, On the Cochituate Water; *A. A. Hayes* and *J. Bacon.*

Statistical View of the United States, being a Compendium of the Seventh Census, by J. D. B. DeBow, Superintendent of the United States Census. *Washington.* 400 pp. 8vo. 1854.

The Quarterly Journal of the Geological Society, vol. xi, Part 1, No. 41. February 1, 1855.

H. T. Stainton: The Entomologist's Manual for 1855. *London,* 1855.

Literary Papers by the late Edward Forbes, F.R.S., with a Portrait and Memoir. *London,* 1855.

R. M. Stark: A Popular History of British Mosses. *London,* 1855. Reeve.

The Artificial Production of Fish; by "Piscarius." *London,* 1854. Reeve.

INDEX TO VOLUME XIX.

N

O

P

R

YALE SCIENTIFIC SCHOOL.

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The next No. of this Journal will be published on the first of July.

CONTENTS.

SCIENTIFIC INTELLIGENCE.

(For remainder of Contents, see third page of Cover.)

39