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ERRATA.

P. 65, l. 16 from bottom, for "nu-mamk," read "nu mank."—Same page, l. 11 from bottom, for "násh-ka-," read "kásh-ka-.—P. 101, in title of article, for "Schlangintweit," read "Schlagintweit."—P. 136, l. 11 from bottom, for "Trempaleon," read "Trempaleau."—P. 140, l. 5, for "contracility" read "contractility;" p. 144, l. 14, for "give" read "given"; p. 149, l. 8 from bottom, for "libani" read "Libani"; p. 150, l. 10, for "specias" read "species"; p. 152, l. 11, for "immediatey" read "immediately;" p. 159, l. 12 from top, for "Civico Museo," read "Museo Civico."

P. 120, l. 13 from bottom, for "T. B. Biot" read "J. B. Biot"; p. 415, l. 5 from bottom, for "order" read "oder"; same page, l. 2 from bottom, for "Der" read "Dr."; p. 450, in part of edition, line 6 from bottom, for "Formation," read "Formations."

P. 207, 9th line from bottom, for *stibiconite* read *stibiconise.*

P. 449, line 21 from bottom, for 'Apppendix' *read* 'Appendix.'

Vol. XXXIII, p. 455, 2d column of Index, 7th line from top, for 417 read 451.

XXXIV, p. 89, 14th and 18th line from top, for *subariel* read *subaerial.*

THE

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[SECOND SERIES.]

ART. I.—*Description of the Remains of a new Enaliosaurian (Eosaurus Acadianus), from the Coal Formation of Nova Scotia;* by O. C. MARSH, B.A., of the Sheffield Scientific School, Yale College.—With Plates.

[Communicated to the Geological Society of London, May, 1862.]

THE Reptilian remains from the Coal-measures, hitherto described, are few in number, and have nearly all been regarded as Batrachian, or Amphibian. Previous to the year 1844, the existence of even this low form of reptilian life during the Carboniferous period was unsuspected by most geologists, and its first appearance upon the earth confidently referred to the Permian epoch. In that year Hermann von Meyer announced the discovery in the Rhenish Bavarian Coal-measures of a reptile allied to the Salamanders, which he described under the name *Apateon pedestris;** and about the same time Dr. King published an account of the footprints of a large Batrachian, which he had observed in the coal strata at Greensburg, Penn.† In 1852 Sir Charles Lyell and Prof. J. W. Dawson obtained in the Coal-measures of Nova Scotia the bones of the *Dendrerpeton Acadianum* (Wyman and Owen), which were the first reptilian osseous remains described from the Carboniferous rocks of America.‡

* Leonhard und Bronn, *Neues Jahrbuch für Mineralogie*, etc., 1844, page 336.

† Description of fossil footmarks (of *Thenaropus heterodactylum*) found in the Carboniferous series in Westmoreland County, Penn.; by Alfred T. King, M.D. Am. Journal of Science, vol. xlviii, page 343. Also in vol. i, new series, page 268.

‡ On the remains of a reptile (*Dendrerpeton Acadianum*, Wyman and Owen), and of a land shell discovered in the interior of an erect fossil tree in the Coal-measures of Nova Scotia; by Sir Charles Lyell, F.R.S., &c., and J. W. Dawson, Esq. Quarterly Journal of the Geological Society, London, May, 1853, vol. ix, p. 58.

Since these discoveries were made, the Coal-fields of England and Nova Scotia, as well as those of Ohio and Pennsylvania, have afforded additional Batrachian, or Amphibian, bones and footprints, so that at the present time the prevalence of this type of reptilian life during the Carboniferous period is generally admitted. The more recent researches of Prof. Dawson in the Coal formation of Nova Scotia have been rewarded by the important discovery of a new genus (*Hylonomus*) of very small reptiles, which, he considers, had affinities to the Lacertians, and possibly belonged to that family, rather than to the Batrachians.*

The remains which form the subject of the following description are of great interest, since they indicate the existence during the Palæozoic period of a group of highly organized marine reptiles of large size, which have previously been found only in Secondary strata. These remains consist of two vertebræ, or more strictly two centra or bodies of vertebræ; and their appearance, when separated from the matrix which contained them, is well represented in the first of the accompanying Plates, figures 1 and 2. The vertebræ were discovered by the writer in August, 1855, while examining the Coal-measures of Nova Scotia in company with his friend, Mr. William E. Park, of Andover, Mass. Their resemblance in form and appearance to the vertebræ of an *Ichthyosaurus* was so marked, that at the time of the discovery the writer referred them to that genus, and made a careful exploration in the vicinity for further remains, but without success. As soon as an opportunity occurred, the fossils were compared with the vertebræ of *Ichthyosauri* from the Lias, and, although some points of difference were noticed, the Enaliosaurian characters seemed to be equally well marked in each. Wishing to obtain, if possible, some additional remains, the writer for some time deferred publishing a description of the vertebræ; but a careful re-examination of the locality during the past summer afforded nothing of a similar nature, and there seemed to be no reason for longer delay in announcing so important a discovery. The remains were, accordingly, briefly noticed by the writer in the last number of the American Journal of Science; and, as they appeared to be generically distinct from any hitherto described, he then proposed for the species the name *Eosaurus Acadianus*, in allusion to the early appearance on the earth of this higher type of reptilian life.†

The locality which furnished these fossils is at the South Joggins Coal formation, in Nova Scotia, on the southern shore of

* Proceedings of the Geological Soc. of London, 1859. Also Supplement to Acadian Geology, page 32.

† From ἠώς, the dawn, and σαῦρος, a lizard. The specific appellation is from Acadia, a former name of Nova Scotia.

the Chiegnecto channel, a branch of the Bay of Fundy. The Coal-measures at this place, according to Sir W. E. Logan,* have a vertical thickness of 14,570 feet, or nearly three miles; and contain seventy-six distinct seams of coal, with erect trees and plants at twenty-two different levels. The strata dip to the south at an angle of about 25°; and the destructive tides of the bay are constantly undermining the high cliffs, and exposing for miles along the coast fresh sections, rich in fossil treasures of vegetable and animal life.

The present remains were imbedded in a stratum of argillaceous chocolate-colored shale, which forms part of group XXVI. in the elaborate section of this formation made in 1852 by Sir Charles Lyell and Prof. J. W. Dawson.† The position of this group is a little more than 10,000 feet above the lower limits of these Coal-measures, and beneath nearly 5,000 feet of coal strata, containing at least twenty separate veins of coal. It is about 800 feet above the locality which afforded the remains of the *Dendrerpeton* and *Hylonomus.*

This group is sixty-six feet in thickness; and consists of chocolate and gray shales, containing ironstone nodules, and interstratified with bands of gray sandstone, in which may occasionally be observed ripple marks, and carbonized land plants. Erect *Sigillariæ*, often of large size, occur at one level, and erect *Calamites* at another. Prof. Dawson considers these deposits estuary or fluviatile sediments, covering flats, which were at times dry, or nearly so, and at others inundated. On one of the rippled sandstones he noticed a series of footprints, which he supposes might have been made by a large *Dendrerpeton.*

Group XXV., immediately beneath the locality of the vertebræ, is about twenty feet in thickness; and consists of a series of underclays, or fossil soils, with *Stigmaria*, and small seams of coal, in which may be seen *Sigillariæ* and *Lepidodendra.* Two feet below group XXVI. there is a stratum of bituminous limestone, which contains the scales of ganoid fishes (*Palæoniscus*), coprolites, bivalve shells of the genus *Naiadites*, and *Spirorbis carbonarius* attached to plants and trunks of *Sigillariæ.*

The vertebræ, as already stated, are two in number; and when discovered were attached to each other, as shown in Plate I. figures 1 and 2. Their uniformity in size and appearance, as well as their collocation when found, would indicate that they belonged to the same animal, and were contiguous in the vertebral column. They are remarkably well preserved; and this results from their complete ossification in their natural state, as well as from the peculiar matrix which has since contained them, and furnished the material for their mineralization. The posterior

* First Report on the Geology of Canada, 1845.

† Transactions Geological Society of London, 1853.

vertebra, in fact, with the exception of a small fracture, seems to be nearly as perfect as in its original condition; and from it the description and measurements which follow are mainly taken.

A close examination of the fossils shows, that, subsequent to the death of the animal, and before being imbedded in the shale, they were subjected to considerable violence. One of them has been pushed aside from its original position about one-third of its diameter, and also turned on its axis about 90°, so as to leave its superior surface in apposition with the lateral surface of its fellow. Through the center of the anterior vertebra an irregular cavity has been made, and a wide fissure separates a segment from the rest of the centrum (Plate I. figure 2). The edges of each of the fossils are somewhat abraded, apparently from having been rolled about by water: this, however, could not have been long continued; as the delicate reticulated texture of the non-articular surfaces, being protected by their slight concavity, is perfectly preserved (Plate I. figure 1, and Plate II. figure 4). These injuries were evidently all received before the entombment of the vertebræ; and, as no similar remains could be found in the vicinity when these were discovered, it is quite probable that the same force, which caused the injuries, also widely separated the different parts of the skeleton.

The general form of the vertebræ is cylindrical, but their sides are somewhat compressed obliquely, which gives to the contour of the centra a subhexagonal appearance. They are much flattened in the direction of the antero-posterior diameter, which has to the transverse diameter about the proportion of 1 to 3. Both the articular terminal facets are deeply and equally concave; but from the center to the margin the surfaces are convex, and this convexity is greatest near the center, as represented in Plate II. figure 2. The cavities for the reception of the intervertebral matter begin immediately from the margin; and are considerably deeper than in the corresponding parts of the *Ichthyosaurus*, indicating a greater degree of flexibility in the spinal column. The margins of the vertebræ are somewhat raised, as if they had yielded to a forcible compression applied longitudinally; and hence the lateral surfaces of the centers are concave in an antero-posterior direction. This concavity is greater in the upper half of the vertebra, and was undoubtedly more marked originally than at present, since the appearance of the margins indicates considerable abrasion. The non-articular surfaces of the centra are smooth and regular; and the external fibres of the osseous tissue are singularly reticulated, as seen in Plate I. figure 1, and in the magnified view, Plate II. figure 4.

The neurapophyses are not anchylosed to the centrum, as in the Mammalia, nor connected to it by sutures, as in the Crocodiles; but their union with the vertebra is indicated by two pits, which served for their articulating surfaces. These depressions are situated on the superior surfaces of the centrum, intermediate between the anterior and posterior margins of the extremities. They are circular in form, and sink directly into the body of the vertebra; instead of being elongated longitudinally, and raised on ridges, as in the *Ichthyosauri.* The pits are about a line in depth, and in the more perfect of the fossils are not in their original position; as a fracture in the upper part of the centrum has pushed them obliquely apart, so that a line passing through their centers would form an angle of about 30° with the transverse diameter of the vertebra. The depressions occupy about one-third of the distance between the margins of the articular extremities, indicating that the base of the neural arch was of less antero-posterior extent than the centrum. The floor of the spinal canal is narrow, being but five lines in breadth; and its surface in the posterior vertebra is broken by the fracture, previously mentioned, which passes lengthwise through its center. No neurapophyses were found with these fossils, but the nature of the superior arch is indicated by the articular surfaces which served for its attachment. Without doubt its ossification was complete, since the neurapophyses are never inferior in this respect to the body of the vertebra. It is also probable that in the present case these parts were anchylosed to each other and to their spine, as in the neural arch of the *Ichthyosaurus.*

A rudimentary transverse process, or exogenous tubercle, is sent off from each lateral surface of the centrum, at points equidistant from the extremities of the vertical diameter (Plate II. figures 1 and 2, *b* and *b'*). Their position is near the margin of the anterior articular surface, and the edges of these parapophyses make the transverse diameter of this extremity somewhat greater than that of the corresponding posterior facet. At the surface of the vertebra, each of these tubercles is about six lines in diameter; but they rapidly diminish in size as they extend outward, and at a distance of one and a half lines from the centrum terminate in obtuse points. They present no indications of articular surfaces; but externally appear to be composed of radiating fibres of osseous tissue, and without doubt served for the attachment of muscles. These elevations resemble in form and position the rudimentary transverse processes on the caudal vertebræ of the *Ichthyosaurus tenuirostris,* and this similarity affords some ground for referring these fossils to the same part of the vertebral column. That their true position is in the anterior or central caudal region, is further indicated by the absence from the centrum of true costal surfaces, or articular depressions for the attachment of ribs, which we should expect to find present in the cervical or dorsal part of the spinal column; and also by the absence of a lateral compression of the centers, which, in the *Ichthyosauri*, marks the posterior caudal vertebræ. Both of the fossils are somewhat injured on their inferior surfaces, and hence it is impossible to ascertain from the specimens themselves whether hæmapophyses originally existed.

The following admeasurements were taken from the nearly perfect vertebra of the *Eosaurus.* For the purpose of comparison, the corresponding dimensions of an anterior caudal vertebra of an *Ichthyosaurus* are added. It will be seen that the most marked differences are in the position and dimensions of the pits for the articulation of the neural arch, and in the depth of the terminal concavities.

ADMEASUREMENTS OF VERTEBRÆ.

	Eosaurus.		*Ichthyosaurus.*	
	inches.	lines.	inches.	lines.
Transverse diameter of centrum on anterior surface,	2	4	2	6
Ditto on posterior surface,	2	3	2	5
Ditto including the parapophyses,	2	6	2	7
Vertical diameter on anterior surface,	2	2	2	3
Antero-posterior diameter on superior surface,		10	1	3
Ditto on inferior surface,		9	1	1
Ditto between centers of articular facets,		1		4
Length of pits for articulation of neural arch,		3		9
Breadth of ditto,		3		2
Depth of ditto,		1		1
Distance between centers of ditto,		5	1	1
Ditto and centers of parapophyses,	1	5	——	

The dimensions of the other vertebra of the *Eosaurus*, so far as they can be accurately ascertained, coincide almost exactly with those given above.

In the margin of one of the vertebræ there is an angular notch, about a line in depth, which deserves to be noticed on account of the importance attached to it by Prof. Agassiz, who first called the attention of the writer particularly to it. Its position is in the upper part of the posterior terminal facet of the centrum, behind and between the pits for the articulation of the superior arch. From the margin, where it is deepest, it extends for a short distance toward the center, and gradually becomes obliterated (Plates I. and II. figure 1, *c*). On the anterior surface of the same vertebra, at a point opposite and nearest to this depression, there is an elevation, which in position and dimensions apparently corresponds to it; and the two, when taken together, naturally suggest that they may be the result of some pressure applied to the anterior surface of the vertebra before it was in its present fossilized condition. Prof. Agassiz, after a casual examination of the vertebræ, expressed the opinion that the notch and elevation were organic, rather than accidental; and as such were indicative of an inferiority of structure, which would place the genus of reptiles to which the remains belong somewhat lower than the *Ichthyosauri.* In a recent letter to Prof. Silliman, Jr., on the subject, he writes as follows:

"Mr. Marsh has shown me to-day two vertebræ from the Coal Formation of the Joggins, which have excited my interest in the highest degree. I have never seen in the body of a vertebra such characters combined, as are here exhibited. At first sight they might be mistaken for ordinary Ichthyosaurus vertebræ; but a closer examination soon shows a singular notch in the body of the vertebra itself such as I have never seen in Reptiles, though this character is common in Fishes. We have here undoubtedly a nearer approximation *to a synthesis between Fish and Reptile* than has yet been seen. * * * * The discovery of the Ichthyosauri was not more important than that of these vertebræ; * * * I do not believe that there is a vertebra known thus far, in which are combined features of so many vertebræ, in which these features appear separately as characteristic of their type."

At the time Prof. Agassiz saw these remains, they were only partially separated from the shale in which they had been imbedded, and consequently his examination could not be perfectly satisfactory. Since then, the matrix has been carefully removed, and an opportunity afforded for comparing the other similar parts of both vertebræ. This comparison, however, shows no corresponding notch or elevation at the opposite points of the same centrum; and none whatever on the other vertebra, where such should exist if these peculiarities were organic.

Prof. Jeffries Wyman, to whom the writer had previously submitted the vertebræ, and to whose kindness he is indebted for many valuable suggestions in regard to them, considers the notch purely accidental; and a result of the same fracture which has displaced the articular pits of the superior arch. It is also the opinion of this eminent anatomist that the notch would not be sufficiently important, if it were organic, to affect at all the Enaliosaurian character of the remains.

A microscopic examination of the osseous structure of these vertebræ of the *Eosaurus* exhibits well-marked Reptilian characters. The Haversian canals are few in number, but large in size, as is usual in this class. The lacunæ, although somewhat irregular in shape, are much elongated, and show very little resemblance to the quadrate or stellate form of the bone cells in fishes. They are frequently arranged concentrically around the Haversian canals, as represented in Plate II. figure 3, and their walls are almost invariably well defined. The canaliculi, as in the *Ichthyosaurus* and *Plesiosaurus,* are not numerous, but appear to be finer than those in most saurians. They do not taper off and ramify, as in the bones of fishes, nor anastomose with the corresponding tubes from the neighboring cells, although in one of the longitudinal sections there are a few indications of such a connection. Some of the other sections examined show a larger number of canaliculi than those in Plate II.; but generally there are only a few of these tubes attached to each lacuna, and in some cases they appear to be entirely wanting. As the canaliculi vary much in number in different saurians, and also with the age of the animal, their paucity in this case is not remarkable. It is possible, however, that the method employed in preparing the sections was not well adapted to rendering these minute tubes visible. In a part of the transverse section shown in Plate II. figure 5, a structure is seen which is quite different from the surrounding osseous substance. This may be due to the presence of a small cavity in the bone before the introduction of the mineral matter, or to an imperfect ossification at that point: more probably the latter, as these vertebræ, like those of the *Plesiosaurus*, show in their interior structure a degree of ossification somewhat inferior to that at the articular terminal surfaces.

The vertebræ of the *Eosaurus*, in their biconcave centers, exhibit a structure which prevails in the class of Fishes; in the Labyrinthodonts, as well as in a few genera of extinct Saurians; and which is seen in existing reptiles only in the Geckos, and the perennibranchiate division of Batrachians. These vertebræ, however, present such marked characters in their very short antero-posterior diameter, in their deep and regular terminal concavities, and in the separate condition of their neurapophyses, that, in determining the position to which their anatomical features entitle them to be assigned, we may safely limit our comparison to the Fishes, and to those genera of extinct Saurians which possessed similar characters.

In comparing these remains with the former class, there is at once apparent a much closer resemblance in the above respects to the vertebræ of the *Plagiostomi*, than to those of any other order. The remains of these fishes have been found in all fossiliferous strata above the Lower Silurian, but no vertebræ except in the more recent rocks. In the Cretaceous and Tertiary formations one family of this order, the *Squalidæ*, have left numerous and well preserved vertebræ; and the writer has carefully compared the remains of the *Eosaurus* with a large number of these and other similar fossils, but could find little resemblance except in form. The vertebræ of the *Eosaurus* show a much higher degree of ossification than those of fishes; and this extends as well to the non-articular surfaces as to the terminal facets of the centers. In the former, there are none of the cavities which are found in the vertebral surfaces of this class; but the osseous structure is firm and compact, as in the corresponding parts of the *Ichthyosaurus.* Moreover, the articular faces at the extremities of these centra present no indications of the concentric rings, formed by the partial projection of the osseous laminæ, which so generally exist on the vertebræ of fossil and existing Sharks.

In the comparison of these remains of the *Eosaurus* with those of fishes, the contrast becomes still more marked as we proceed toward the older formations. The ossification of the vertebral column in the Mesozoic fishes was much less complete, and in some orders almost entirely wanting; while in all the Palæozoic species, yet discovered, the notochord was persistent, and consequently no bodies of vertebræ have been preserved. Negative evidence, therefore, would strongly indicate that these perfectly ossified remains should be referred to a higher grade of animals. A microscopic examination, also, of these vertebræ shows that they possess a structure essentially different from that seen in the corresponding bones of fishes; it is, then, evidently necessary, considering all the points of divergence, to reject that class, and place the *Eosaurus* among the *Reptilia.*

From the extinct Reptiles possessing biconcave vertebræ, with which we have to compare these remains, we may at once set aside the orders *Ganocephala* and *Labyrinthodontia* of Prof. Owen; since in these, according to the present state of knowledge, either the notochord was persistent, as in the *Archegosaurus;* or, when a higher degree of vertebral ossification was attained, the neurapophyses were anchylosed to the centrum. Among the Crocodilians, nearly all from the Secondary formations had vertebræ of the amphicœlian type; but, inasmuch as the centrum was terminated by very shallow cavities, and had the superior arch united to it by suture, it will be unnecessary to give further consideration to this group. In the *Sauropterygia* biconcave vertebræ also prevail, but they are all more or less elongated, except in the cervical region of the *Pliosaurus,* where they have nearly the proportions of the present remains. In this case, however, the articular extremities of the centrum were flat, or very slightly concave, and consequently this genus may likewise be rejected.

The remaining orders of extinct Saurians exhibiting the biconcave structure of vertebræ, with the single exception of the *Ichthyopterygia,* differ so essentially, in their known remains, from these vertebræ of the *Eosaurus,* either in the length of the centrum, in the depth of its co-adapted cavities, or in its union with the neural arch, that we may evidently terminate the comparison with the important genus on which that order has been founded.

It will readily be seen from the previous description, that a very close resemblance exists between these vertebræ and those of the *Ichthyosaurus*. This is especially noticeable in their flattened and subhexagonal form, in their deep and regular terminal concavities, and in the separate state of the neural arch. The differences which exist, however, although of much less importance, must not be disregarded. The most marked of these have already been alluded to; and may be seen in the absence from the sides of the centrum of costal articular surfaces, in the deeper concavities at the vertebral extremities, and in the form and dimensions of the superior arch. The first of these differences would alone be deemed sufficient, by the highest authority, to establish a distinction between these remains and the vertebræ of the *Ichthyosaurus;* for in that genus, according to the statement of Prof. Owen, which is peculiarly applicable to the present case,—"The lower tubercle for the attachment of the rib never wholly quits the centrum: any detached vertebral centrum, therefore, that might be discovered, which had no lateral tubercle or articular surface for a rib, might be safely pronounced, whatever the form of its anterior and posterior articular surfaces, not to have belonged to a true *Ichthyosaurus*, provided it was not compressed laterally, as in the small terminal ribless caudal vertebræ which supported the caudal fin in the *Ichthyosaurus*."* The absence of any lateral compression in the present remains, together with their size and proportions, prove conclusively that they cannot be brought under the exception, which Prof. Owen makes of the terminal caudal vertebræ of the *Ichthyosaurus;* and hence the application of his rule would separate them from that genus.

The points of similarity, then, between these vertebræ of the *Eosaurus*, and those of the *Ichthyosauri*, which they most resemble, clearly indicate that they belong to the same natural group of marine reptiles, and to the same order; while the differences which exist between them seem to be sufficiently numerous and important to authorize the conclusion that they are generically distinct; as might naturally be expected from the vast periods of time that separated their existence.

Since the genera of Enaliosaurians from the Secondary formations, although contemporaneous, differed so widely in form and structure, analogy would lead us to infer that a Palæozoic representative of the family would present still more marked peculiarities in these respects. It is, therefore, particularly interesting to find indications of so strong a resemblance between this primitive saurian and the more recent *Ichthyosaurus*. These fossils, however, present some features of a lower and more ichthyic type of structure than that genus possessed, and it is not unlikely that other parts of the skeleton would show a wider divergence.

* Report on British Fossil Reptiles, Part I, page 102.

These vertebræ of the *Eosaurus*, although the only remains of the genus at present known, are so characteristic and well preserved that they afford considerable evidence in regard to the structure and habits of the animal to which they belonged. They indicate that this reptile, like the later Enaliosaurians, was of great size,* air-breathing, cold-blooded, and carnivorous; that it was aquatic, and probably marine, inhabiting the sea or estuaries; or possibly, as might be inferred from the place of its entombment, the mouths of rivers flowing into the sea.† The flattened form of the vertebræ; the great depth of their terminal concavities; the separate condition of the neural arch; and its short longitudinal extent at the base,—all are consistent with the conclusion that the *Eosaurus* was capable of rapid progress through the water in pursuit of its prey, which was probably fishes; and since it had then, according to our present knowledge, no superior in point of size, it must have reigned supreme in the waters of the Carboniferous era.

As the vertebræ which have been described in this paper were discovered in 1855, they are, consequently, so far as the writer is aware, the first osseous remains of a true air-breathing Saurian from the Coal formation; and the only *Enaliosaurian* remains yet obtained from below the Upper Triassic. Occurring as they do in Palæozoic strata, they add another to the arguments that have been brought against the so-called "Development Theory;" and they show with how great caution we should receive the assertions, so frequently and confidently made on negative evidence alone, of the exact date of the creation or destruction of any form of animal or vegetable life. They prove, moreover, that during the deposition of the Coal-measures the atmosphere was sufficiently free from the destructive gases, which, as many suppose, had contaminated it, to permit the existence of a high type of air-breathing reptiles. This period was, in fact, the foreshadowing of an age, then far in the future, when Reptilian life should hold undisputed sway upon the earth, until in turn supplanted by a higher and a nobler form of existence.

* If we suppose the number of vertebræ and the relative length of the head of this saurian to have been the same as in the *Ichthyosaurus*, its entire length must have been between twelve and fifteen feet, which is at least three times the extent of any reptile hitherto found in Palæozoic strata.

† Although the strata which contained the vertebræ are probably fluviatile or estuary deposits, this would not preclude the possibility of their containing marine remains; as the waters from which they were precipitated were undoubtedly so connected with the sea that an occasional transfer of the inhabitants from one to the other might readily be made: analogous cases are not uncommon at the present time.

CHEMICAL EXAMINATION OF THE REMAINS OF THE EOSAURUS ACADIANUS.

A comparison of the composition of recent and fossil bone is interesting, both in a chemical and a physiological point of view; and has already attracted some attention. As it is desirable to add to the limited amount of data on this subject hitherto collected, the writer has analyzed a portion of a vertebra of the *Eosaurus*, and the results obtained are given below.

A preliminary qualitative examination of the fossils having shown the presence of iron, manganese, copper, alumina, lime, magnesia, potash, soda, organic matter, and water; as well as fluorine, chlorine, sulphur; silicic, carbonic, phosphoric and sulpuric acids, the complete separation of these numerous constituents was necessarily attended with some difficulty.

The following is a general outline of the methods employed in the analysis: The finely powdered substance was first dried over sulphuric acid, and then divided into several portions, between one and two grammes each. One of these was fused with carbonate of soda; and the resulting mass dissolved in dilute chlorhydric-acid: the solution was then evaporated to dryness in a water bath, and the silicic acid present was separated and determined in the usual manner. From the filtrate which remained, the copper was precipitated by sulphuretted hydrogen; and, as the amount of this metal in the substance was small, the precipitate was converted into oxyd of copper by moistening it with nitric acid, then ignited and weighed. The lime was next separated from the remaining solution by sulphuric acid, in the presence of an excess of alcohol, and determined as sulphate. When the alcohol had been removed from the last filtrate by evaporation, the organic matter destroyed and the manganese oxydized by chlorate of potash, the solution was made alkaline by ammonia, and the iron, manganese, alumina, magnesia, fluorine, and part of the phosphoric acid present, were thus precipitated. After washing with ammonia water to prevent the solution of the magnesia salt, the precipitate was dried, ignited and weighed. To ensure the complete separation of the phosphoric acid, a weighed portion of iron was converted into the sesquichlorid, and added to the preceding filtrate; the resulting phosphate of iron was then precipitated by ammonia; ignited, weighed, and the amount added to the weight of the previous precipitate. The two were then redissolved in chlorhydric acid, and the phosphoric acid in the substance separated by molybdate of ammonia. This precipitate was next redissolved in caustic ammonia; the phosphoric acid again precipitated by the addition of sulphate of magnesia and chlorid of ammonium, and finally determined in the form of basic phosphate of magnesia.

The quantity of sulphur contained in the substance was not estimated directly; but was calculated from the amount of copper present, with which it was united in the form of copper pyrites, as ascertained by the preliminary examination. The alumina was estimated by deducting the amount of the other ingredients from the weight of the two ammonia precipitates. The manganese, magnesia, chlorine, fluorine, and sulphuric acid were not present in sufficient quantities to admit of accurate determination.

A second portion of the original substance was dried at 100° C. until the weight became constant, and the loss estimated as water. The remaining anhydrous substance was next ignited at a red heat for some time in an open crucible; and when it ceased to lose weight, the organic matter* which it had contained was estimated from the loss, after deducting the amount of the carbonic acid and the sulphur, which had also been expelled. The residue was then treated with chlorhydric acid, the solution evaporated to dryness, and the silicic acid separated as before. The iron, alumina, and phosphoric acid, as well as the traces of manganese, magnesia, and fluorine in the filtrate, were then removed by ammonia. The precipitate thus obtained was redissolved in chlorhydric acid, and the quantity of iron contained in it determined volumetrically by permanganate of potash. The filtrate from the ammonia precipitate was next evaporated to dryness and gently ignited to remove the ammonia salts, and then treated with hydrate of lime. From the filtrate which remained the potash and soda were obtained in the usual manner, and first weighed together as chlorids: they were then redissolved, and their respective amounts calculated from the quantity of chlorine in the solution, which was determined volumetrically by nitrate of silver.

In a third portion of the original substance the carbonic acid was estimated in the usual way, from the loss of weight after treatment with dilute chlorhydric acid.

The material taken for analysis was part of a segment from the lateral surface of the vertebra, which remained after preparing the microscopic sections. The following were its physical characters: Compact, with uneven fracture. Hardness, 3·5. Specific gravity at 20° C., 2·78. Lustre dull. Color brown. Opaque.

* It is not unlikely that a portion of the loss by this process was merely water, so combined with some of the constituents of the substance that it was not expelled below the heat of ignition.

The results of the analysis were as follows:

Water,		·82
Organic matter, and combined water?		2·39
Peroxyd of iron,		10·21
Protoxyd of manganese,		*trace.*
Alumina,		20·15
Lime,		24·96
Magnesia,		*trace.*
Potash,		·39
Soda,		1·10
Copper pyrites,	copper,	1·22
	iron,	1·07
	sulphur,	1·20
Fluorine,		*trace.*
Chlorine,		*trace.*
Phosphoric acid,		11·40
Carbonic "		20·89
Silicic "		5·04
Sulphuric "		*trace.*
		100·84

The matrix of the fossils was an argillaceous shale, colored with peroxyd of iron; and without doubt many of the constituents of the remains were derived directly from this source by infiltration, the silicic acid, alumina, peroxyd of iron, and alkalies, resulting from the decomposition of clay.

The small amount of manganese in the substance was found to exist as protoxyd, and was probably combined with a part of the silicic acid. Protoxyd of iron also was present, but its separation from the higher oxyd, being in this case unimportant, was not attempted: the estimated quantity of the peroxyd given above is, consequently, somewhat greater than the true amount. The protoxyd of iron, as well as part of the lime, probably existed in the fossils as carbonate. The phosphoric acid was undoubtedly combined with the iron and lime.

The fluorine in these vertebræ was in smaller quantity than has generally been found in fossil bones, and differs widely from the amount obtained by Baumert, who found 16·67 per cent of fluorid of calcium in the remains of the *Zeuglodon*.* The results of the present analysis tend to confirm the opinion of Middleton and others that the presence of fluorine in fossil bones is accidental; and that the large amount of this substance occasionally found is due to infiltration; and is not, as some writers have affirmed, an original constituent of the remains.

The organic matter in these remains may have been partially derived by infiltration from the fossil plants contained in the surrounding matrix of shale: a careful examination, however,

* Liebig und Kopp, Jahresbericht für 1851, p. 594.

seemed to indicate that a portion of it was of animal origin; and this has probably been preserved from the original substance of the vertebræ.

The estimation of the organic matter in many analyses of fossil bones, which have been published, is based on the loss by ignition. This method, if alone employed, as is usually the case, is liable to give very erroneous results, especially where the quantity of organic matter is small; since the mineralizing substances, introduced into the fossils by infiltration, not unfrequently may contain in close combination a considerable amount of water, which remains at temperatures much above those ordinarily used in desiccation. Loss by ignition, therefore, in analyzing such remains, is no proof of the presence of organic matter; and the results thus obtained are worthless in this respect, unless the existence of this substance has been otherwise ascertained. The nature of the organic matter also should be determined; as in animal remains from the older rocks it is occasionally due to infiltration, and may be entirely of vegetable origin.

In the present analysis the following method was employed for the detection of the animal organic matter supposed to be present in the fossils: A portion of the finely powdered material, between one and two grammes in weight, was placed in a beaker, and a small quantity of distilled water added; the vessel was then closely covered, and left on a sand bath where the temperature was just sufficient to cause a gentle ebullition. The heat was continued, and the water renewed from time to time, for several days, to effect the solution of any animal organic matter the fossils might contain. The insoluble portion was then filtered off, and the liquid evaporated to dryness in a platinum capsule, when the residue, on gentle ignition, carbonized, and distinctly afforded the characteristic odor of burning nitrogenous tissue. This, or some equivalent method of proving the presence of animal organic substances, should always be employed in analyses of this kind, especially where a complete separation of the organic ingredients is not attempted.

A nitrogen determination was made on a portion of the material somewhat different from that used in the preceding analysis, and gave ·776 per cent. for the amount of that substance in the remains. This corresponds essentially with the results obtained by M. Delesse, who has made somewhat extensive researches on this point; and who considers that the quantity of nitrogen in fossil bones is, within certain limits, a reliable indication of their age.* The substance used in the above determination was evidently different from that previously employed; as the amount of nitrogen obtained would indicate a much larger quantity of gelatigenous tissue than the analysis showed to be

* Comptes Rendus de l'Acad. des Sci. de Paris, 1861, tome lii., p. 728.

present in the portion first examined. Part of the nitrogen may have been derived from ammonia, which is sometimes introduced into fossils by the infiltrating waters. A want of sufficient material prevented fuller investigations of the organic elements in these remains.

The fossil bones hitherto analyzed appear to have been all from the more recent formations; the present analysis, however, of a Palæozoic fossil does not differ materially in most respects from the results previously obtained.

Yale College, April 15th, 1862.

EXPLANATION OF THE PLATES.

PLATE I.

Vertebræ of the Eosaurus Acadianus (natural size).

Figure 1. Oblique lateral view of the vertebræ, with the posterior articular surfaces above.

a. Pits for the articulation of the neurapophyses.

b. Rudimentary transverse process on the right lateral surface of the centrum.

c. Notch, or depression, in the posterior margin of the centrum.

Figure 2. Oblique view of the vertebræ, with the anterior articular surfaces in front.

a, a'. Pits for the articulation of the neurapophyses.

b. Rudimentary transverse process on left lateral surface.

b'. Ditto on right lateral surface.

PLATE II.

Vertebræ of Eosaurus (natural size), *with magnified sections.*

Figure 1. Posterior view of the more perfect vertebra.

a. Pits for articulation of neurapophyses.

b. Rudimentary transverse process on left lateral surface.

b'. Ditto on right lateral surface.

c. Notch, or depression, in the margin of the centrum.

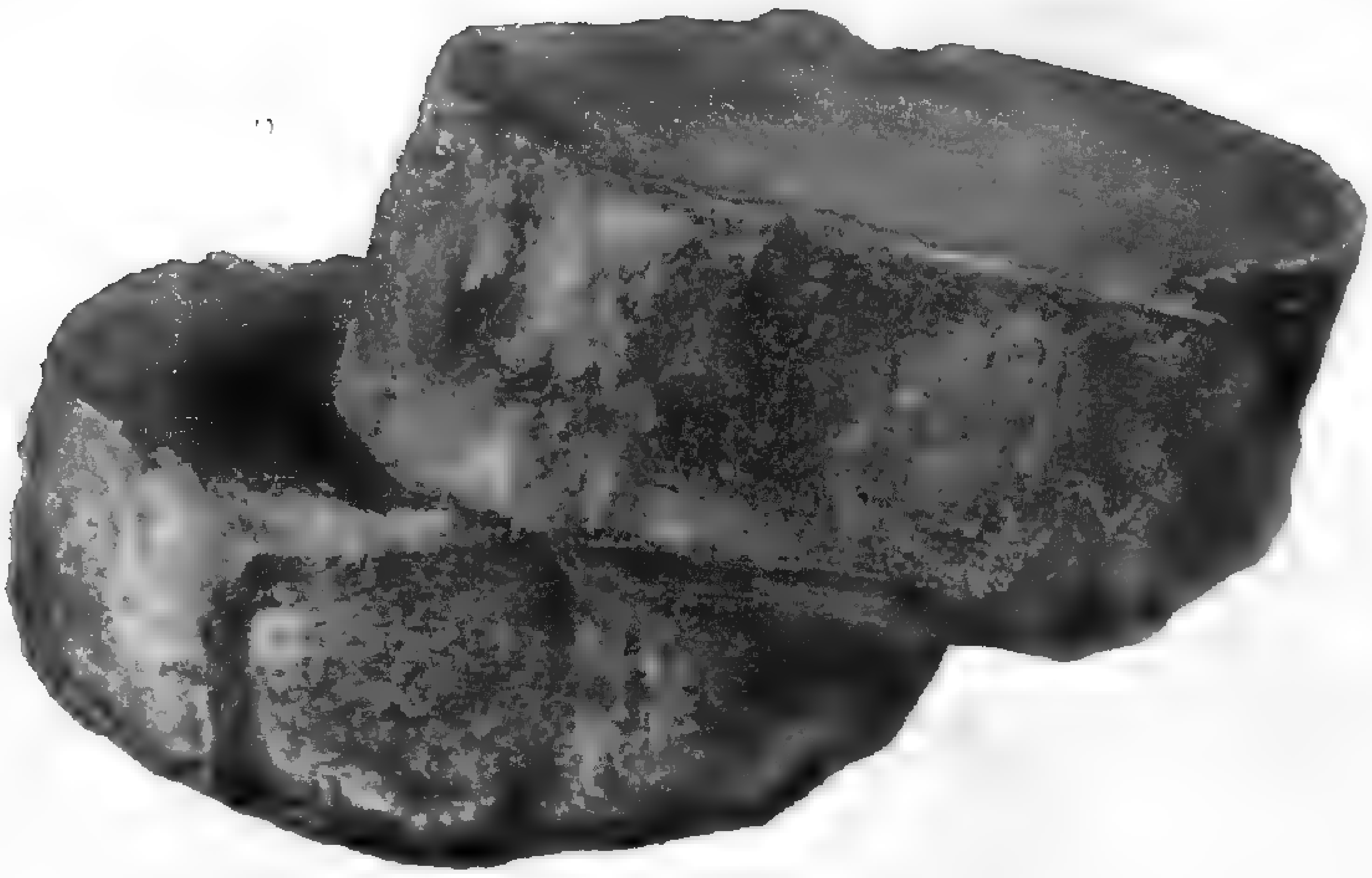
Figure 2. Transverse section of the same vertebra, showing the deep concavities of the articular terminal facets, and the rudimentary processes at *b* and *b'*.

Figure 3. Longitudinal microscopic section, from near the lateral surface of the centrum, showing the elongated lacunæ arranged concentrically around an Haversian canal. (Magnified 350 diameters.)

Figure 4. View of the reticulated osseous texture on the lateral surface of the centrum. (Magnified five diameters.)

Figure 5. Transverse microscopic section, from near the articular surface of the centrum. (Magnified 350 diameters.)

1



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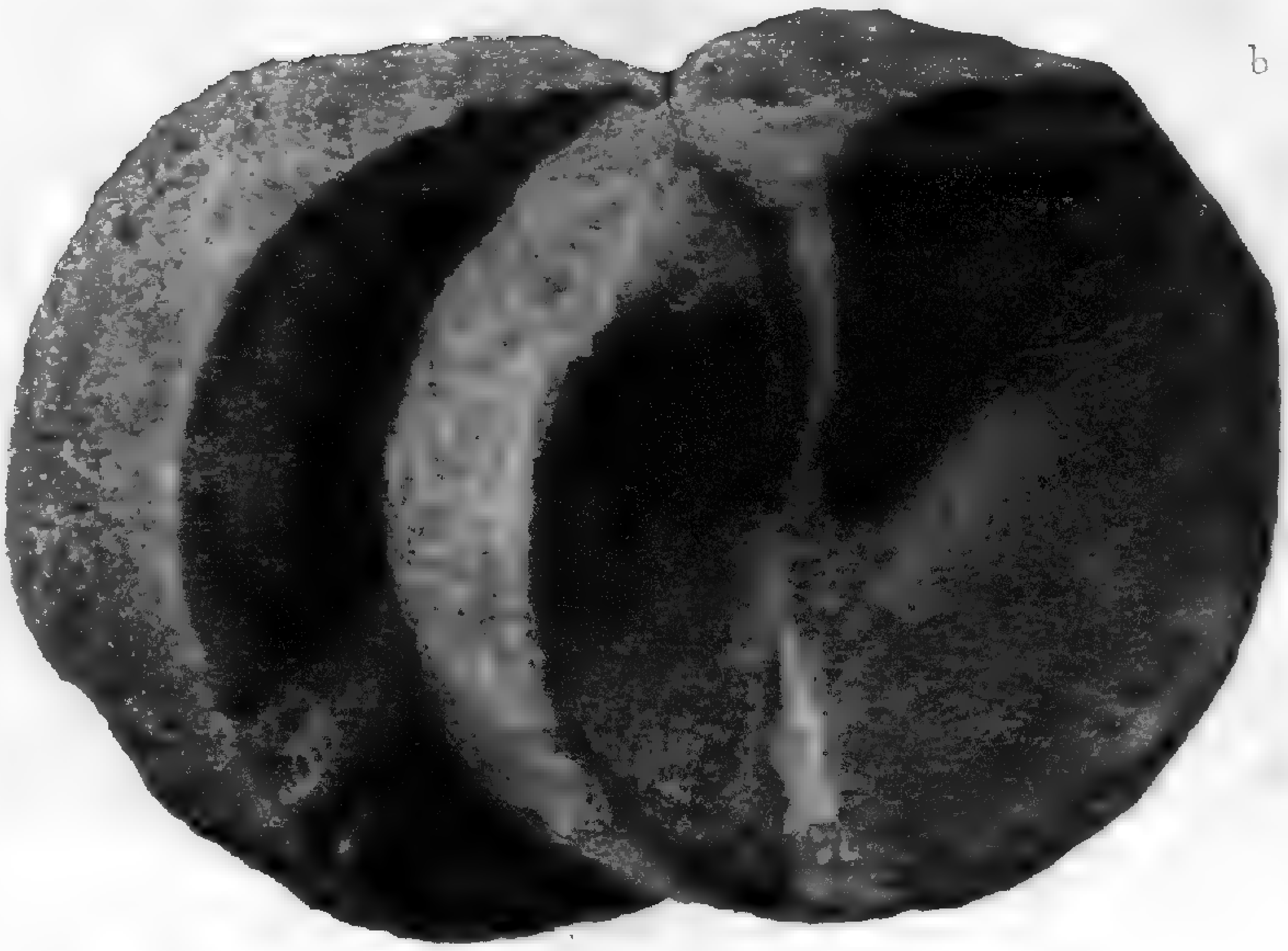


VERTEBRAE OF EOSAURUS ACADIANUS

PLATE I.

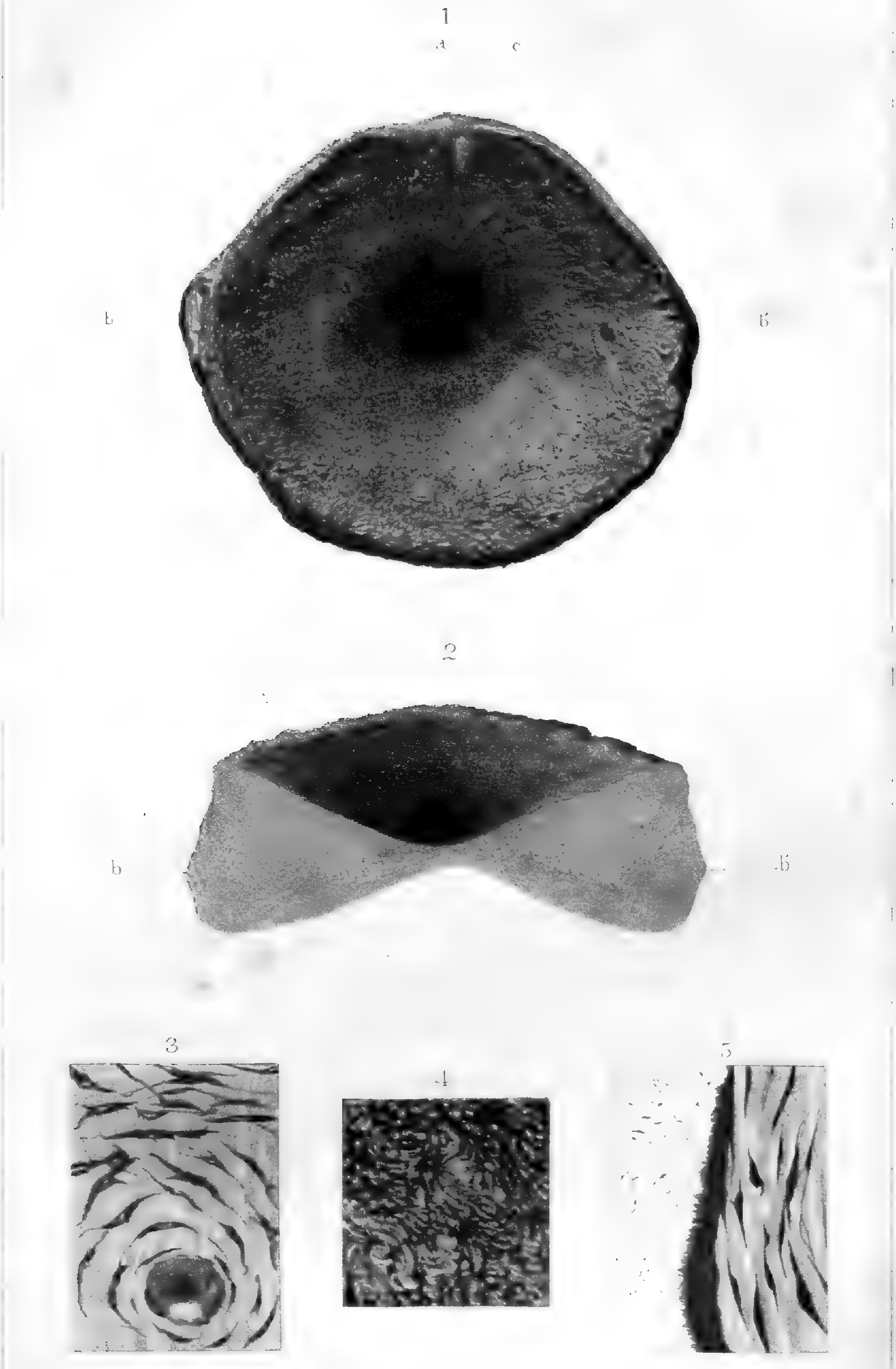


Photo. by M. W. Filley

Eng.d by A. H. Ritchie

VERTEBRAE OF EOSAURUS ACADIANUS

Art. II.—*The Physiology of Sea-sickness;* by Richard Meade Bache, Assistant U. S. Coast Survey.

(Read before the Connecticut Academy of Arts and Sciences, January 15, 1862.)

All that is known about sea-sickness is, that certain involuntary motions of the body produce an effect upon the nervous system. This effect results in nausea. This nausea is called sea-sickness. The question is not solved, as to the manner in which the nervous impression is produced.

It is generally supposed, that sea-sickness is produced by the mere motion of the body, and consequently of the stomach. That it is produced by motion, is not to be denied, but as wherever sea-sickness occurs, motion is the pervading concomitant of existence—the thing most patent of all that is evident to the senses, and the body is so unpleasantly subjected to it, we lose sight of the fact, that with the body are also subjected all the senses or perceptive faculties, and that these are called upon to comprehend an entirely novel state of existence.

I have said, that the mere action of motion upon the body is supposed to produce the nausea called sea-sickness. I hope to be able to overthrow this theory by the arguments and proofs of another theory, which I am about to advance.

The points which I intend to prove are—that the agreeableness of motion is a mere matter of habit—that motion however violent is not nauseating "per se" but only inasmuch as it produces an impression conflicting with its ordinary contrasted effects as pre-established in the mind, that the idea of motion is the result of concurrent testimony of the senses—and, that in novel motions, there is a violation of the conception of motion derived from the habitual concurrence of the testimony of the senses—that as the result of this violation, a conflict of impressions ensues, and the brain is affected—thence the nervous system, and nausea results. In fine, I maintain that sea-sickness is a disease of the brain, and not of the stomach, except incidentally, or as affected by the brain, although, it is true, that the stomach reacts upon the brain.

I now commence my argument in which I have attempted a procedure, which, I trust, cannot fail to bring conviction of the truth of the theory to any one who will carefully analyze it. In all statements of facts which I have introduced I have taken the experience of others, as well as my own.

The appearance of motion when the observer knows that his own body is at rest, is not nauseating. To ascertain the effect of the mere appearance of motion under these circumstances, we can take no better example, than that of a train of cars drawn by a locomotive at full speed. The more rapid motions of the heavenly bodies are not appreciable by our senses. We have conception of them through the mind, but not through sight or hearing, therefore I have chosen the motion of railway trains for the purpose of illustrating the effect of the mere appearance of motion. Standing as near, or as far off, as one pleases, from a train of cars in rapid motion, no more nauseating effect is produced upon the spectator, than by the sight of any object at rest. Yet the appearance of motion is nauseating in *two* cases—but these are where the idea of motion of the body is involved, that is, where motion of the body of the observer is either in *debate* by the mind, or *acknowledged* by the mind and the motion is not *felt.* If this can be made to appear, it is additional proof, that the mere appearance of motion is not nauseating, or as I shall henceforth express it for convenience, the appearance of motion is not nauseating "per se." As an example of the first case—that the appearance of motion is nauseating "when motion of the body of the observer is in *debate* by the mind"—take the following: In a dimly lighted depot, two trains of cars stop side by side—presently one starts—so gently that an occupant of one of the trains cannot decide whether it is his own train which is in motion, and consequently whether it is his own *body* which is in motion or whether the motion perceived, is that of the other train. This produces a sensation of uncomfortableness—of giddiness—indicative that nausea would result if the effect were continued. At all events, it produces an impression of motion of the body, which impression is derived through the instrumentality of the sight, and which impression affects the nervous system unpleasantly—yet the body of the observer may have been at rest all the while. As an example of the second case—the assertion "that the appearance of motion is nauseating when motion of the body of the observer is *acknowledged* by the mind, and the motion is not *felt,*" one illustration, as in the first case, will suffice. In the slight trembling of an earthquake, when the jar would have escaped notice, but for the faint oscillation of a chandelier which calls attention to the existence of an earthquake—this oscillation through the impression which it gives the observer, that his body is in motion, often causes the sensation of nausea. It is impossible that the motion of the body of the observer could cause the sensation, for the case spoken of is one where the existence of the earthquake would not have been known, but for the oscillation of the chandelier. The sensation could not have proceeded from the mere perception of the motion of the chandelier, because such an object can be viewed while swinging violently, without any sensation being produced, other than the perception of its swinging.

The cause of the disagreeable sensations just described, is owing to the fact that nature requires our senses to keep pace. The sight must not proclaim what the feeling does not at once corroborate and "vice versa." In the first case, nervous impression was produced by doubt in the mind of the observer as to whether his body was or was not in motion, and in the second case, by the consciousness of motion of the body, which motion was not *felt*. In neither case, did the senses keep pace, consequently the nervous impression ensued, and consequently nausea. It is evident, although the sight was the agent in these results, that it was *only* the agent, and it was the imagination which produced the effects. Sight was the intermediary. It may be safely inferred from the effect of the appearance of motion in the two cases just cited—that if a man believing himself in his senses, should see a landscape glide by, he would become nauseated, yet it is evident that the nausea would proceed from the involved idea of motion—the idea that he might be in motion without feeling it—for if he knew it was only the landscape which he saw that was in motion, he would regard it with terror, but without other sensation, and it would affect him as a passing train of cars when he knew that his own body was at rest—that is, it would not affect him at all, as far as nauseation is concerned.

We see then, that the appearance of motion "per se" does not nauseate, and we see too, how the nervous system is impressed by the imagination so as to bring about nausea.

The senses from the earliest infancy have grown up and been educated together, to act in harmony. It requires habit to render them capable of keeping pace together in a novel condition of existence. The motion communicated to the body by riding in a carriage, is by no means violent, notwithstanding which, persons in early life, frequently become nauseated while thus riding. This is merely because the sense of sight and the feeling of a certain motion have not been educated together. This I shall proceed to show. It is well known, that persons perfectly habituated to riding in a certain position in a carriage, object to riding with the back towards the direction in which they are proceeding, on the plea that it makes them sick to do so. It doubtless has that effect, but it is impossible for the effect to be produced by the mere motion in that position, for it is impossible in a carriage in motion in the dark, to decide in what position one is sitting in relation to the line of progress, unless some obstacle should interpose, or the road should be so bad as to afford an equivalent to a number of obstacles in the way, or unless the driving is of such a character, by sudden turnings and abrupt increasing or slackening of speed, as to indicate to the occupant of the carriage the position in which he must be sitting. In a word, in ordinary conditions of progress in a carriage, it is impossible in the dark to determine in what position one is sitting. This is not generally known. Experiment will prove my assertion to be true.

It has been already shown, that the appearance of motion "per se" does not nauseate. How then is a person accustomed to riding in a carriage, nauseated by riding with the back towards the direction in which he is proceeding, for the appearance of motion "per se" does not nauseate, nor can motion "per se" nauseate in *that* instance. The effect is derived from consciousness of motion perceived by two senses at least, while at the same time, the appearance of objects violates the habitual impression produced by the sight of them. In the dark, the effect must be derived from pure imagination. If we grant then, that a particular mode of progress in a carriage can nauseate one accustomed to a carriage (and it is often seen) and we grant at the same time, that appearance of motion "per se" is not nauseating (and this I have proved) and we know also, in the case spoken of, that motion "per se" could not have produced the sensation of nausea (because the motion is the same in any position, and the person is habituated to one) we must then acknowledge that the nausea is produced neither by the motion "per se," nor by the appearance of motion "per se," but by a conflict of the two senses of feeling and sight. If this can be inferred in the case of one accustomed to the motion of a carriage, it must apply with more force to one unaccustomed to it.

So thoroughly have the senses created a conception of motion, that the exclusion of sight does not alter the idea of its appearance, nor alter the idea of the appearance of violation of preconceived effects. The mental picture is always present. If the exclusion of the sight did alter these ideas, the closing of the eyes would in one of the cases just mentioned, save from nausea a person unaccustomed to riding in a certain position, and in the other case, would secure immunity from nausea to the person unaccustomed to riding at all. But it does not save them, which shows that the mental picture of progress and of unwonted effects, takes the place of that produced by actual vision. It is immaterial whether the sight is acting or not acting. Whatever senses exist in an individual, have conjointly created a well defined idea of the contrasted effects of motion, and this conception is always evident to the mind without the continued intervention of all the authors of the conception.

Having shown that a certain motion is nauseating, but is not nauseating "per se," we may fairly infer that no motion is nauseating "per se." Perhaps in very violent motions, there may be some mechanical effect produced by the movement of the stomach—this is not a primary cause of sea-sickness, but an aggravation of it. Otherwise, it must be supposed that the stomach of a sailor becomes entirely changed in its nature.

The law to be deduced from what I have attempted to demonstrate is this—that the violation of the habitual conception of contrasted effects of motion, is the cause of the nauseation which occurs during novel motions—and the cause is not motion "per se," nor the appearance of motion "per se."

If such effects as those just described in the case of riding in a carriage can nauseate, when they are produced by comparatively slight changes in "the habitual conception of contrasted effects of motion" it is not surprising, that the effect of motion at sea should bring the great and continuous nausea called sea-sickness. The motions of a ship vary infinitely. As soon as a certain kind of motion has lasted for a long time, the voyager becomes accustomed to it, and he has no more tendency to become nauseated, than has the man accustomed to a carriage. He may, however, become sick again, if the motion should vary, and yet not be increased. A person habituated to the sea, may remain ashore for a long time, but his senses readily accommodate themselves again to conditions once understood. It is true, that even old sea captains are sometimes afflicted by sea-sickness, but this does not invalidate the theory which I have advanced. There are temperaments so predisposed to sea-sickness, that the inuring process has to be perpetually renewed. I do not assert, that the same amount of experience at sea, gives the same immunity to each person. The causes which I have mentioned as superinducing sea sickness affect every one, but the capability of resisting it varies with every temperament. There are individuals who never become sea-sick—that is to the extent of succumbing to nausea—but they undergo the same process of education of the senses. The difference between these persons and those who do succumb, is that their organizations in physique and temperament enable them to resist the inclination to nausea and the education of the senses is completed before nausea has been able to overcome them, although it always attacks. There is no one, who in a first experience at sea, is not disposed to nausea, but there are some few persons, who possess such organizations, that with the aid of a firm determination to resist an attack of sea-sickness they are enabled to escape it, and to pass the ordeal of the novel motion at sea without manifest inconvenience.

At sea, motion immediately nauseates, even when it is much less than may be experienced in a swing without the slightest impression. In a swing, motion is comparatively regular. It requires little education of the senses to enable them to keep pace with each other. The evidence of the sight is nearly the same as that of the feeling. If a person in a swing is blind, or keeps the eyes shut, there are still measures of the extent of motion. These measures are firstly the points of highest elevation and greatest depression—secondly, the corresponding intervals of time—thirdly, the perception of the rush in progressing through the atmosphere, for not only does the cessation of the rush indicate the points of greatest elevation, but its increase or diminution, indicates continuously all other points. Hearing may also be mentioned, as it contributes to the conviction of the mind as to the uniformity of the motion to which the body is subjected when swinging. All these certainly give a most accurate idea of the segment of a circle which the body is describing in the air. Nausea can be produced in a swing, but it requires very little education of the senses to enable a person to bear the motion.

I have been told by a person who attempted to prepare himself for a sea voyage by using a swing, that the process was entirely unavailing—yet I doubt very much, whether the motion to which one is subjected at sea, is often greater than can be attained in a well constructed swing. But the motion of a swing is quite uniform—that at sea far from it, and the failure of the swing to inure a person to unequal motion, shows that it is not motion which affects us, but inequality of motion, and that it is not the mere mass of flesh and digestive organs which are alone concerned, but other elements as appurtenances of the body demand our consideration, and as I hope to prove, merit it, far more than the mere body and stomach, which becoming diseased only react. If it be said, that animals, such as horses and dogs, become sea-sick, and yet have no such nice senses as we have, excepting perhaps scent;—I answer by saying, that a horse is always terrified at movement in which he does not see the cause, even terrified at perfectly noiseless movement. What is it which prompts a young dog to jump at all hazards from a vehicle in rapid motion, even when driven by his own master, and what makes him eventually delight in riding? Preconceived ideas of motion when violated bring terror to both horse and dog. The conditions of novel motion, once accepted, the senses are reconciled and habit is the result. If then we allow these animals to possess habitual conception of motion, they must be affected at sea as human beings are—in the same manner if not in the same degree. The tumbler pigeon precipitates itself with a revolving motion towards the earth, but does not appear to be at all affected by the motion which its body has undergone. If the same bird is taken in the hand and its head placed under one of its wings and it is then whirled around, it may be placed on a table, and during a few moments it will appear lifeless. Aquatic birds of the greatest vigor in flight, and habituated to floating on stormy waves, often become nauseated on the decks of vessels.

Let us now consider the motions at sea. A ship rolls, plunges, seems to pause, then dart, and every movement brings the passenger increased uneasiness. There is no precedent in his experience for such movement. If he possesses sight, the view of objects is at variance with all that he has been habituated to in other motions. If he is blind, his mental conception—the picture in his mind—is equally at variance with his habitual conception. In a few days, in either case, the person would be indifferent to the motion. He will have learned, in the meantime, to reconcile the evidence of his senses. If he possesses sight, it will have been educated in conformity with unequal motions, just as it was educated from childhood to comparatively equal ones, or if he is blind, his conception of the appearance of motion, will have been reconciled with motion experienced. In either case, it is the conception of the appearance of motion, as contrasted with the feeling, which conception will have reconciled itself with existing conditions. Both those who see, and the blind possess this habitual conception, which is never shut out from the mind as has been shown. Closing the eyes will not discard it. If it did, every one subjected to unusual motion could in that way, secure immunity from nausea. This has been shown not to be the case.

Let us now consider the peculiar effect of unequal motions upon the human body. It is my conviction that motion is nauseating whenever the estimate of its extent does not correctly precede it. The mind mechanically calculates what is to take place while it is taking place.

I shall now endeavor to show, that "motion is nauseating whenever the estimate of its extent does not correctly precede it." I have already shown that motion is not nauseating "per se." I have also shown, that when it does nauseate, it is when the brain is impressed. The question naturally suggests itself here, as to what there is in the impression produced on the brain which affects us unpleasantly and produces nausea. It is the idea of undefined movement of the body of the observer. Back of this I do not pretend to go. Nature has so constituted us, that undefined motion is repugnant to our organizations. Nauseation from motion proceeds from the idea present to the imagination, that the body is the subject of undefined motion. The nauseation of sea-sickness, of course, eminently proceeds from undefined motion. But to the proof—an experiment which any one can make. I have often lain awake at night in the cabin of some great ship at sea, and guaged the motion and calculated the capability of the passengers to resist an access of nausea. Choose a time, when there is a regular sea and wind, when the ship ploughs along pretty evenly. Now and then, seas will rise somewhat higher than the rest. Sea-sick passengers habituated to uniform motion—at the intervals when the ship has been accustomed to rise or to fall, feel that they rise still higher or fall still lower. The difference in motion is not perceptible in violence, and yet causes many to give involuntary evidence of the occupancy of their state rooms. The strain of fancy is ever exerted and *solicitous* to imagine and attain the turning point, although after it is gained, the motion, as in a descent, may be still more rapid. Let any one who has been at sea, recall how trying was a continuous movement in one direction, even a long rise upon a wave, when the motion is certainly not as swift as in a descent, and at the same time remember, how small the motion of a long gliding rise or descent is, as compared to much that one is subjected to at sea—how much less violent. The effect upon the observer is produced simply by the difference of motion—by ignorance of the extent to which it is going—by the idea of undefined motion. When one's senses are educated in the novel condition of existence at sea, the motion is no longer undefined. A ship could make no movement which would not be accompanied by a corresponding idea of space passed through. There is no motion at sea which by habit will not cease to appear undefined, but if it were possible for a ship to mount heavenwards, and to sink rapidly near to the bottom of the sea in alternate movements, it is my belief, that the hardiest sailor would become sea-sick.

The summary of what I have attempted to demonstrate is this, that sea-sickness is not the result of motion "per se," nor of the appearance of motion "per se," but is the result of the senses "violating the habitual conception of contrasted effects of motion" and producing on the brain the idea of undefined motion. When the senses are educated to form coöperating and agreeing measures of the novel condition of existence at sea, nausea ends. If they never formed these measures nausea would never end.

For another proof of this theory, take the case of an infant. Instances of children in arms being sea-sick are very rare.* A child certainly feels the motion, that is to say its body is subject to the motion equally with that of the oldest passenger. But a child undergoes motion without *feeling* it. It sees too, without *perceiving*. In its case nothing conflicts. It is as ready to be rocked on the billows as in its cradle. Its youth precludes the possibility of its having any habitual conception of motion from the education of the senses, and if it feels any sensation, that sensation is at variance with nothing. As soon as children begin to "take notice," as it is called, the education of the senses begins, and thus we find, that children shortly afterwards, at the age of two and three years, are attacked by sea-sickness, but they recover long before adults are secure from it. The case of a blind man, because he cannot see, and consequently cannot perceive, is not

* A medical friend has handed us the following note on a case of his own observation.—Eds.

While I was surgeon on the emigrant packet ship "Webster," (1861,) I recollect a case of a girl (an infant) at the breast dying of sea-sickness. The child was perfectly healthy when passed by the Inspecting Medical Officer in Liverpool, and continued to be so, apparently till after we discharged our Pilot at Holy Head. On the evening of the first day out, it was very rough and blowing hard, and consequently a large number of passengers, both adults and children, were afflicted with sea-sickness (Morbus Nauticus). They all eventually recovered with the exception of this child. It had all the symptoms of sea-sickness, such as loss of appetite, vomiting, a cool clammy skin, tongue thickly coated in the middle, and a weak feeble pulse. In spite of good medical treatment, it continued to fail rapidly with debility, till we arrived in long. 27° when it died. Dr. E. S. Bissell.

in any respect similar to that of an infant, for I have shown, that the mental picture may conflict with reality, and the blind man has the mental picture—the idea of space—motion—speed—everything—excepting color. Not only are babies not usually afflicted with sea-sickness, but just in proportion to the youth of children, are they exempt from it. Since my own observation indicated what has been asserted in regard to the immunity of babies from sea-sickness, I have enquired of persons of experience, whether their observation tended in the same direction, and I have been confirmed in my belief.*

It has been asked by a friend, to whom I communicated this theory of sea-sickness, whether the insane are sea-sick, and an answer in the negative would certainly seem to corroborate the theory. Thus far, however, I have been unable to ascertain, as the insane are so rarely allowed to go to sea, that it would require long and patient investigation to determine the point. Immunity from sea sickness in a very few cases might be a mere coincidence. As far as the answer has been made to my enquiries, I shall give the result. I know of two persons, who, there is every reason to believe never had been at sea until a voyage, when they labored under the "mania à potu." These persons did not become sea-sick. Another case of which I have reliable information, is that of a young girl, who was insane, and who was taken

* Among the latest testimony which I have received, is a letter written by Captain R. P. Manson of Bath, Maine. This letter is subjoined. Much other testimony has been received verbally, or is my own testimony derived from close observation and comparison during a series of years. The remark that it is impossible, in a carriage in motion in the dark for the occupant to decide in what direction he is sitting in relation to the direction of progress, is one which I heard made by my father many years ago, at a period when I was but a child. Memory treasured this alleged fact, and not suspecting for a moment, that the determination of its truth would ever be of any service, beyond the mere verification of a curious fact, I was able subsequently to investigate it, and to ascertain its entire correctness, and now it forms a very important link in the chain of evidence which I have adduced in support of my theory of sea-sickness. I have often received the testimony of others on various points, by merely listening to their descriptions of certain sensations, and thus I was generally enabled to avoid what might prove leading questions.

Letter of Capt. R. P. Manson.

Bath, Oct. 14th, 1861.

R. M. Bache, Esq.,

"*Dear Sir:*—Your letter regarding sea-sickness has been received, and I most cheerfully comply with your request—offering any information (which has come under my observation during thirty years actual services as shipmaster mostly in the European business) which you may deem relative or interesting to that subject.

In answer to your questions regarding children—I have never known an infant, nursing—sea-sick, and children from the age of two and a half up to four or five years, are not often sea-sick, when so, the attack is but short, slight, and seldom returns. Such, I believe, is in conformity with your own views: it is what I have invariably observed with many hundred emigrant families.

I will mention I once knew one of the worst cases of sea-sickness completely and almost instantly cured by fear. Respectfully your ob't serv't,

R. P. Manson."

to sea by her father, who was the captain of the ship. She too was not sea-sick. I should be very sorry to mar a strong case of evidence in favor of the theory which I have advanced, by an assertion of the truth of which I am not positive, even if I were willing to state any thing of which I am not absolutely certain. I give my investigation of this subject, for what it is worth in the thoughts of those who may read this article. I shall not support my theory in any measure whatever upon the result of that slight investigation. Therefore I do not assert, that the insane are not liable to sea-sickness.

I think it sufficiently clear from all that has been said, that impression of the brain is the cause of nausea on the ocean, since I have shown, that it is not motion "per se" nor the appearance of motion "per se" which causes it, but an *idea*, which I have termed one of undefined motion, derived when the body is subjected to motion in an unusual manner, from the "violation of the habitual conception of contrasted effects of motion." There are minor causes of sea-sickness, or rather, not so much causes as aggravations of it. These are close cabins, smell of bilge-water, unusual food, and as I have said, the stomach reacts upon the brain.

A precaution frequently taken by people about to commence a sea-voyage, is to eat nothing or scarcely any thing. Another precaution taken, is to get immediately into a berth. Neither plan is good. Neptune is the most insatiable highwayman on the globe, and attempts to levy toll on all. The traveller who comes totally unprovided, fares badly, if he cannot successfully resist. In plain English, the stomach is weakened by want of food, and is therefore more liable to be acted upon in the production of nausea, and if nausea should ensue, retching is probably more distressing without than with food. Lying down is an excellent plan to adopt for the purpose of avoiding nausea, but when the posture is assumed in a berth with the nauseous smell of bilge water around and as is often the case, with a tin vessel of questionable nicety, hooked on the edge of the berth, the plan is no better than the first.

Persons frequently imagine that some particular article of food cured their sea-sickness. It is a general rule, that whatever a sea-sick person is able to eat at all while sick, or convalescent, gets the credit of the cure. The most heterogeneous articles are spoken of as specifics. The best preparation to avoid sea-sickness, is to go aboard ship with the stomach supplied with its accustomed amount of food. It is best, as far as possible, to maintain the habits of shore.

Many reasons combine to render the deck of a vessel in any thing like fair weather, the proper place to remain, either to avoid sea-sickness, or to recover from it. It is there, that the sight can be more quickly educated to the movement, than it can be in the cabin. The crests and troughs of the seas can be observed, and thus it can be seen, just how far one has to rise—just how far to fall. Persons will frequently find, that the view of the waves has a beneficial effect in stilling nausea, suffered more severely in the cabin. This is not only on account of the fresh air on deck, but because in the cabin, the idea of motion is more undefined. The view of the horizon also, has a most beneficial effect. The horizon is the only object which has the appearance of remaining stationary, and the motions of a ship are readily graduated by keeping the gaze directed to it. On deck the miserable sea-sick passenger can breath the fresh air, in lieu of the conglomerate smells in a cabin aboard ship. He can also choose a position amid-ships, where there is the least motion of any place on deck. Then there are more agreeable objects to look at on deck, and beyond, than in the cabin, and it is very important that the mind should be distracted from the passing scene—or, what is disagreeable or most so in it. In a foot-note, I have adverted by a quotation to a case, where a woman who had been prostrated for some days by sea-sickness, was immediately and completely cured, owing to the action of terror on her mind, resulting from the belief that the ship was foundering, and this case is by no means isolated.

If in addition to what has been recommended, the passenger will spread a mattress, and put himself in a recumbent posture, all will then have been done, that can be done, to prevent, to cure, or to alleviate sea-sickness, until the education of the senses is completed.

ART. III.—*On the Empirical Interpolation of Observations in Physics and Chemistry;* by W. P. G. BARTLETT.

THE object of the present paper is to bring to the notice of physicists some methods of interpolation; not that there is any principle in them new to mathematicians, but because no proper methods appear to be practically within the reach of many of those engaged in making such observations in physics and chemistry as require interpolation.

Whatever difficulty there is in the problem arises from our entire ignorance of the form of the function which the observations follow, and from the necessarily irregular intervals at which they are made.

Every method of interpolation under these conditions amounts to *assuming* some formula involving arbitrary constants, and determining the values of these by elimination from the equations furnished by the observations.

If all the observations are required to be rigorously satisfied, Lagrange's formula,

$$y=\frac{(t-t_1)(t-t_2)(t-t_3)\ldots}{(t_0-t_1)(t_0-t_2)(t_0-t_3)\ldots}y_0+\frac{(t-t_0)(t-t_2)(t-t_3)\ldots}{(t_1-t_0)(t_1-t_2)(t_1-t_3)\ldots}y_1$$
$$+\frac{(t-t_0)(t-t_1)(t-t_3)\ldots}{(t_2-t_0)(t_2-t_1)(t_2-t_3)\ldots}y_2+\text{\&c.},$$

is probably as good a way as any of arranging the elimination, since it is only necessary to multiply the various factors to obtain the function y, developed in powers of the variable t; y_0, y_1, &c., being the observed values corresponding to the values t_0, t_1, &c., of t.* Otherwise the determination of the constants may be made either so as to satisfy exactly some of the observations, or so as to satisfy them all within moderate limits—say the probable errors of the observations themselves. The former proceeding is theoretically imperfect, because it makes some of the observations of no account whatever in determining the values of the constants, using them, if at all, only to help the selection by successive trials of the form of the function. The latter is generally impracticable in a direct form, unless the constants enter linearly into the equations, in which case the method of *least squares* will always give good results; but if besides this, the successive terms in the development, either of y, or of any given function of y, form a convergent series, it will generally be advantageous to use Cauchy's method, which, *notwithstanding its violation of the law of probable error*, is practically sufficient, and indeed far the best, for almost all the physical formulæ that it is worth while to develop at all in an *empirical series*.

This method not being, like *least squares*, generally accessible in a working form, it is proposed to devote special attention to its operation. Its principle is to neglect at each step all the terms of lower orders, leaving in general a form

$$z=a\,u,$$

and then of all the values

$$\frac{k_0z_0+k_1z_1+k_2z_2+\text{\&c.}}{k_0u_0+k_1u_1+k_2u_2+\text{\&c.}}$$

which might be given to the constant a, by assigning different sets of values to the k's, to select that in which the k's are all so taken $(=\pm1)$ that the denominator above written becomes the

* If there are $m+1$ observed values of y, there will be only $\frac{1}{2}m(m+1)$ *different* factors to be computed in all the denominators of the formula above written; and it is evident from the theory of equations, that the coëfficient of t^{m-r} in the numerator (expanded in powers of t) of the coëfficient of y_n will be $(-1)^r$ times the sum of the products formed by every possible combination of r different factors, t_0, t_1, *&c., omitting from the sum the terms containing* t_n; which involves for the whole work only $2^{m+1}-(m+3)$ different products of two or more terms each, and therefore only this number of multiplications.

absolute sum of the special values of u.* To show more distinctly how the numerical application is to be made, we shall here arrange some formulæ for computation, changing for this purpose some of Cauchy's notation and giving the development an entirely different form.

Let it be assumed, as usual, that the observed quantity y, converges when developed in the form

$$(1) \qquad y = \mathrm{A} + \mathrm{B}t + \mathrm{C}t^2 + \text{\&c.}$$

If this assumption does not give, on trial, a convenient formula, the logarithm or any other function of y may be tried in the place of y, and its development made in precisely the same way. It will be easy to see, moreover, that any variables we please may be substituted for the different powers of t, *provided only the series is convergent.* The function will first be developed in the form

$$(2) \qquad y = \mathfrak{A} + \mathfrak{B}\Delta t + \mathfrak{C}\Delta^2 t^2 + \mathfrak{D}\Delta^3 t^3 + \text{\&c.}$$

in which Δt, $\Delta^2 t^2$, &c., are functions of the form $a+bt+ct^2+$&c. and are respectively of the first, second, &c., degrees in t. The numerical values of $\mathfrak{A}$, $\mathfrak{B}$, &c., and the expressions for Δt, &c., being found, the series (2) is immediately reducible to the form (1). Let s be the number of observations given to determine A, B, &c.; then the formulæ required in practice are

$$(3)\left\{\begin{array}{ll}
\multicolumn{2}{l}{\alpha_1 = \frac{\Sigma t}{s}, \quad \alpha_2 = \frac{\Sigma t^2}{s}, \quad \alpha_3 = \frac{\Sigma t^3}{s}, \ldots\ldots\ldots\ldots\ldots \alpha_n = \frac{\Sigma t^n}{s}} \\
\multicolumn{2}{l}{\Delta t = t - \alpha_1, \quad \Delta t^2 = t^2 - \alpha_2, \quad \Delta t^3 = t^3 - \alpha_3, \ldots\ldots \Delta t^n = t^n - \alpha_n} \\
\multicolumn{2}{l}{\quad \beta_2 = \frac{\Sigma' \Delta t^2}{\Sigma' \Delta t}, \quad \beta_3 = \frac{\Sigma' \Delta t^3}{\Sigma' \Delta t}, \ldots\ldots\ldots\ldots\ldots \beta_n = \frac{\Sigma' \Delta t^n}{\Sigma' \Delta t}} \\
\multicolumn{2}{l}{\quad \Delta^2 t^2 = \Delta t^2 - \beta_2 \Delta t, \; \Delta^2 t^3 = \Delta t^3 - \beta_3 \Delta t, \ldots \Delta^2 t^n = \Delta t^n - \beta_n \Delta t} \\
 & \gamma_3 = \frac{\Sigma'' \Delta^2 t^3}{\Sigma'' \Delta^2 t^2}, \ldots\ldots\ldots\ldots \gamma_n = \frac{\Sigma'' \Delta^2 t^n}{\Sigma'' \Delta^2 t^2} \\
 & \Delta^3 t^3 = \Delta^2 t^3 - \gamma_3 \Delta^2 t^2 \ldots \Delta^3 t^n = \Delta^2 t^n - \gamma_n \Delta^2 t^2 \\
\mathfrak{A} = \frac{\Sigma y}{s} & y' = y - \mathfrak{A} \\
\mathfrak{B} = \frac{\Sigma' y'}{\Sigma' \Delta t} & y'' = y' - \mathfrak{B}\Delta t \\
\mathfrak{C} = \frac{\Sigma'' y''}{\Sigma'' \Delta^2 t^2} & y''' = y'' - \mathfrak{C}\Delta^2 t^2 \\
\mathfrak{D} = \frac{\Sigma''' y'''}{\Sigma''' \Delta^3 t^3} & y^{\text{iv}} = y''' - \mathfrak{D}\Delta^3 t^3
\end{array}\right.$$

* For the complete analysis, which is quite simple, the reader is referred to the original lithographed memoir published in 1835, or to its republication in 1837 in Liouville's *Journal de Mathématiques*, tome ii, page 193. The same thing is also appended as a note to the first volume of Moigno's *Calcul Différentiel*, page 513; and a partial translation of it in the *U. S. Coast Survey Report* for 1860, p. 392.

Σ, Σ', &c., indicate the algebraic sum of the s values of the respective functions before which they are placed; but before taking the sum Σ', the signs of all the numbers corresponding to the cases in which the values of Δt are negative, and including these values themselves, must be changed. Similarly before taking Σ'', Σ''', &c., signs must be changed throughout for the cases in which $\Delta^2 t^2$, $\Delta^3 t^3$, &c., respectively are negative. So that $\Sigma' \Delta t$, $\Sigma'' \Delta^2 t^2$, $\ldots \Sigma^{[m]} \Delta^m t^m$ are the absolute sums of these quantities. The following equations

$$(4) \qquad \Sigma^{[m]} \Delta^n t^p = 0, \quad \Sigma^{[m]} y^{[n]} = 0$$

are true for all values of n greater than m, and may therefore be used as *checks*. Each of the conditions (4) breaks up (except the case in which $n=1$) into two more convenient partial sums; for, denoting the sum of all the values of a function corresponding to positive values of $\Delta^m t^m$ by $\Sigma^{[m]}(+)$, and of those corresponding to negative ones by $\Sigma^{[m]}(-)$, the equation

$$\Sigma = 0 \text{ is equivalent to } \Sigma^{[m]}(+) + \Sigma^{[m]}(-) = 0, \text{ and}$$
$$\Sigma^{[m]} = 0 \quad \text{"} \quad \text{"} \quad \Sigma^{[m]}(+) - \Sigma^{[m]}(-) = 0; \text{ whence}$$

$$(5) \qquad \Sigma^{[m]}(+) = 0, \qquad \Sigma^{[m]}(-) = 0,$$

which may take the places of Σ and $\Sigma^{[m]}$ in the form (4). There might occur cases in which this principle of subdivision could be carried on still farther. The advantage of using (5) instead of (4) lies in the narrower limits within which it is necessary to look for an error discovered by means of (5).

The special forms of the various functions are written out in (3) as far as will suffice for determining four terms in the value of y, and computing y^{iv} so as to test the accuracy of the approximation and apply the checks (5) to it. An inspection of (3) will show:

1st, that the first term, $\mathfrak{A}$, is simply the *average value of y.*

2d, that to determine the second term it will be necessary to compute y', α_1, Δt, and $\mathfrak{B}$:

3d, for the third term, y'', α_2, Δt^2, β_2, $\Delta^2 t^2$, and $\mathfrak{C}$:

4th, for the fourth term, y''', α_3, Δt^3, β_3, $\Delta^2 t^3$, γ_3, $\Delta^3 t^3$, and $\mathfrak{D}$: and so on till the residual quantities, $y^{[m]}$, are seen to be small enough to be neglected.

If more special forms are desired besides those written out in (3), the law of their formation is obvious from an inspection of those actually developed there. It is such that, in general, if μ and $\mathfrak{M}$ be the mth letters in their respective alphabets, then

$$\mu_n = \frac{\Sigma^{[m-1]} \Delta^{m-1} t^n}{\Sigma^{[m-1]} \Delta^{m-1} t^{m-1}}, \qquad \Delta^m t^n = \Delta^{m-1} t^n - \mu_n \Delta^{m-1} t^{m-1}$$

$$\mathfrak{M} = \frac{\Sigma^{[m-1]} y^{[m-1]}}{\Sigma^{[m-1]} \Delta^{m-1} t^{m-1}}, \qquad y^{[m]} = y^{[m-1]} - \mathfrak{M} \Delta^{m-1} t^{m-1}.$$

It will be observed that no cases occur in which n is less than m.

To get out symmetrically the coëfficients of (1) it is easy to find that they are of the following forms:

$$(6)\quad\left\{\begin{array}{lllll} A= \mathfrak{A}+[1]\mathfrak{B} & +[2]\,\mathfrak{C} & +[3]\,\mathfrak{D} & + \text{ \&c.} \\ B= \quad\;\;\; \mathfrak{B} & +[2']\mathfrak{C} & +[3']\,\mathfrak{D} & + \text{ \&c.} \\ C= & \quad\;\;\; \mathfrak{C} & +[3'']\mathfrak{D} & + \text{ \&c.} \\ D= & & \quad\;\;\; \mathfrak{D} & + \text{ \&c.} \\ \quad\;\; \text{etc.} & \quad \text{etc.} & \quad \text{etc.} & \end{array}\right.$$

in which

$$\begin{array}{lll} [1]=-\alpha_1 & & \\ [2]=-\alpha_2-\beta_2[1] & [2']=-\beta_2 & \\ [3]=-\alpha_3-\beta_3[1]-\gamma_3[2] & [3']=-\beta_3-\gamma_3[2'] & [3'']=-\gamma_3 \\ \quad\text{etc.} & \quad\text{etc.} & \quad\text{etc.} \end{array}$$

EXAMPLE.

[Löwel's Solubility of Anhydrous $NaO\,SO_3$ in water, developed in powers of t−50°.—*Annales de Chimie et Physique*, xlix, 50.]

	y	t	t^2	t^3	y'	Δt	Δt^2	Δt^3
1.	5325	−32·00	1024·0	− 32768	+487·5	− 27·684	+ 400·9	− 39445
2.	5276	30·00	900·0	27000	438·5	25·684	276·9	33677
3.	5153	25·00	625·0	15625	315·5	20·684	+ 1·9	22302
4.	5131	24·00	576·0	13824	293·5	19·684	− 47·1	20501
5.	5037	20·00	400·0	8000	199·5	15·684	223·1	14677
6.	4971	17·00	289·0	4913	133·5	12·684	334·1	11590
7.	4953	16·00	256·0	4096	115·5	11·684	367·1	10773
8.	4878	9·85	97·0	956	+ 40·5	5·534	526·1	7633
9.	4781	− 4·96	24·6	− 122	− 56·5	− 0·644	598·5	6799
10.	4682	+ 0·40	0·2	0	155·5	+ 4·716	622·9	6677
11.	4542	9·79	95·8	+ 938	295·5	14·106	527·3	− 5739
12.	4435	20·61	424·8	8755	402·5	24·926	− 198·3	+ 2078
13.	4296	34·42	1184·7	40779	541·5	38·736	+ 561·6	34102
14.	4265	+53·17	2827·0	+150314	− 572·5	+ 57·486	+2203·9	+143687
Σ	67725	−60·42	8724·1	+ 93482	0	+ 0·004	+ 0·7	+ 4
Σ′					−3935·0	279·936	+2833·3	+334798

	y''	$\Delta^2 t^2$	$\Delta^2 t^3$	y'''	$\Delta^3 t^3$	y^{iv}	
1.	+ 98·4	+ 681·2	− 6335	+ 6·3	−18220	+ 8·3	$\alpha_1=-4{\cdot}316$
2.	77·5	536·9	− 2959	+ 4·9	12326	+ 6·3	$\alpha_2=+623{\cdot}1$
3.	24·8	211·3	+ 2436	− 3·8	− 1251	− 3·7	$\alpha_3=+6677$
4.	+ 16·8	+ 152·2	3041	3·8	+ 386	3·8	
5.	− 21·0	− 64·3	4081	12·3	5203	12·9	$\beta_2=+10{\cdot}125$
6.	44·8	205·7	3580	17·0	7169	17·8	$\beta_3=+1196{\cdot}0$
7.	48·7	248·8	+ 3201	−15·1	7542	−15·9	
8.	37·3	470·1	− 1014	+26·3	7188	+25·5	$\gamma_3=+17{\cdot}447$
9.	65·6	592·0	6029	14·3	+ 4300	13·8	
10.	89·2	670·6	12317	+ 1·5	− 617	+ 1·6	$\mathfrak{A}=\ 4837{\cdot}5$
11.	97·2	670·1	22610	− 6·6	10916	− 5·4	
12.	− 52·1	− 450·7	27733	+ 8·8	19870	+11·0	$\mathfrak{B}=-14{\cdot}057$
13.	+ 3·0	+ 169·4	− 12227	−19·9	−15182	−18·2	
14.	+235·5	+1621·9	+ 74884	+16·2	+46587	+11·0	$\mathfrak{C}=+0{\cdot}1352$
Σ′(+)	0	− 0·1	− 3	0	+ 2	0	
Σ′(−)	+ 0·1	+ 0·7	+ 2	− ·2	− 9	− ·2	$\mathfrak{D}=+0{\cdot}000111$
Σ″	+911·9	6745·2	+117681	−·1 −·1	−6 −1	−·1 −·1	
Σ‴				+17·4	156757	−·1 −·1	

	$\beta_2\Delta t$	$\beta_3\Delta t$	$\mathfrak{B}\Delta t$	$\gamma_3\Delta^2 t^2$	$\mathfrak{C}\Delta^2 t^2$	$\mathfrak{D}\Delta^3 t^3$	
1.	− 280·3	− 33110	+ 389·1	+ 11885	+ 92·1	− 2·0	[1]= + 4·316
2.	260·0	30718	361·0	9367	72·6	1·4	[2]= − 666·8
3.	209·4	24738	290·7	3687	28·6	− 0·1	[3]= − 206
4.	199·3	23542	276·7	+ 2655	+ 20·6	0·0	
5.	158·8	18758	220·5	− 1122	− 8·7	+ 0·6	[2′]= − 10·125
6.	128·4	15170	178·3	3589	27·8	0·8	[3′]= − 1019
7.	118·3	13974	164·2	4341	33·6	0·8	
8.	56·0	6619	77·8	8202	63·6	0·8	[3″]= − 17·4
9.	− 6·5	− 770	+ 9·1	10328	79·9	+ 0·5	
10.	+ 47·7	+ 5640	− 66·3	11700	90·7	− 0·1	A= 4686·6
11.	142·8	16871	198·3	11694	90·6	1·2	B= − 15·539
12.	252·4	29811	350·4	− 7863	− 60·9	2·2	C= + 0·1333
13.	392·2	46329	544·5	+ 2955	+ 22·9	− 1·7	D= + 0·000111
14.	+ 582·0	+ 68753	− 808·0	+ 28297	+ 219·3	+ 5·2	

In this example, to which Cauchy's method is applied, the numbers in the column y express the solubility* of anhydrous sulphate of soda in 10,000 parts of water at 14 different temperatures,—column t contains the corresponding temperatures *less* 50° (for convenience of development). The work is carried as far as the determination of four terms in the development according to powers of (temp. −50°); but a comparison of the values of y^{iv} with those of y''' shows that nothing is gained by the addition of the fourth term. Since the values of A, B, &c., are obtained by using (6) it is not necessary to obtain the coefficients a, b, &c., at all. In taking the sum Σ' the signs are to be changed in the first nine cases; therefore $\Sigma'(+)$ means the algebraic sum of the last five cases, and $\Sigma'(-)$ that of the first nine. $\Sigma''(+)$ is the algebraic sum of the 1st, 2d, 3d, 4th, 13th and 14th cases, and $\Sigma''(-)$ of the rest. $\Sigma'''(+)$ includes the 4th, 5th, 6th, 7th, 8th, 9th, and 14th, and $\Sigma'''(-)$ the rest. The values of $\Sigma''(+)$ and $\Sigma''(-)$ are written on the same horizontal line opposite the argument Σ''; similarly with $\Sigma'''(+)$ and $\Sigma'''(-)$ for y^{iv}.

M. Bienaymé has shown† that if each case of the equations,

$$\begin{array}{llll} y = & A + Bt + Ct^2 + \&c. & & \\ y' = & B\Delta t + C\Delta t^2 + \&c. & & \\ y'' = & & C\Delta^2 t^2 + D\Delta^2 t^3 + \&c. & \\ \text{etc.} & \text{etc.} & \text{etc.} & \end{array}$$

were multiplied by the proper *least-square* factor (different for each case and for each of these equations) before taking the sums Σ, Σ', &c., the process would become merely another form for the expression of the elimination in *least-squares* given by Gauss‡ and others.

The advantages of Cauchy's method are its simplicity, the ease

* According to Löwel, *Annales de Chimie and Physique*, xlix, page 50.

† *Comptes Rendus*, tome xxxvii, 4 Juillet 1853; and Liouville's *Journal de Mathématiques*, xviii, page 299. See also Cauchy's Note, *Comptes Rendus*, xxxvi, 27 Juin, 1853.

‡ In the *Disquisitio de elementis Palladis*; and translated into French on page 137 of the *Méthode des Moindres Carrés*.

with which the important check (5) is applied to the work, and the fact, which is of great importance in many of its applications to physics, that it is not necessary to determine beforehand how many coefficients A, B, &c., are to be eliminated. The objections, which seem fatal to it as a substitute for *least squares* where the latter is properly applicable, are of very little importance in cases where the form of the function is wholly assumed and the formula therefore only to be trusted within the limits of the series of observations; for in these cases the formula which gives a minimum value to the sums of the squares of the differences between the computed and observed quantities, is not necessarily better than many others giving other sets of properly distributed small differences, especially as "the errors of observation" are frequently mixed up with others *of the same order of magnitude,* arising from errors in the values of the variables, t, t^2, &c.

If however the series of observations is very extensive (like those, for instance, on the tension of steam) the labor of finding an empirical formula becomes altogether greater than its value, and it is better to *tabulate* the function without reference to any "interpolation-formula" satisfying the whole or even any great number of the observations. For this purpose the observed quantities must first be reduced to equidistant values of the variable, and then these may easily be interpolated to as frequent intervals as we please by the methods in common use.

To accomplish the first object there are several methods. The mechanical one of *plotting a curve* (however valuable in suggesting *the true physical law* of the phenomena) cannot often be used for this purpose with as much accuracy as computation. In the method of interpolation by "*divided differences*"* each determined place depends only on a very few of the adjacent observations, and a series of such places, unless the observations were accurate to the last figure, would not be apt to harmonize. Another way is as follows: let one of the equidistant values of the variables be t_0, then the observations may be represented, *in the vicinity of* t_0, by the series,

$$(7) \qquad y = A + B(t - t_0) + C(t - t_0)^2 + \&c.$$

in which A is obviously the required value of y corresponding to $t = t_0$, and may be determined in each case from as many observations as we please to use. Cauchy's *method* applied in this way to some of Regnault's observations has been found to give an accurate table of vapor-tensions with very little labor. Determinations of A were made for every 6° of temperature from 9° to 39°, and ten observations were used for each determination.

* See Lacroix, *Calcul*, tom. iii, p. 31, § 903; or De Morgan, *Calculus*, p. 550.

ART. IV.—*On Electrical currents circulating near the Earth's surface, and their connection with the phenomena of the Aurora Polaris.*—9th ARTICLE; by ELIAS LOOMIS, Professor of Natural Philosophy and Astronomy in Yale College.

IN vol. xxxii, pp. 324–335 of this Journal, I have shown the existence of a stream of electricity drifting across Central Europe in a direction from about N. 28° E. to S. 28° W. For several months I have been collecting the materials for a similar discussion in this country, and now present the results of these enquiries. My materials are derived from the magnetic observations made at Toronto, Cambridge and Philadelphia, from May 1840 to Dec. 1842, and during a portion of this time at Washington also. The observations at the first three stations were made with needles mounted in the manner recommended by Gauss; but those at Washington were made with a declination compass having a needle of eleven inches in length, whose motions were much less free than those of Gauss' construction, and which therefore did not give the time of the maxima and minima with equal precision. For this reason the last column in the following table contains a large number of blanks. The table exhibits a list of all those cases in which there was a well marked maximum or minimum value of the magnetic declination, and when this maximum or minimum value was of short duration. All the dates are expressed in the mean time of Göttingen.

OBSERVED DEFLECTIONS OF THE HORIZONTAL MAGNETIC NEEDLE.

			Toronto.		Cambridge.		Philadelphia.		Washington.	
			h.	m.	h.	m.	h.	m.	h.	m.
1840.	May 29.	Maximum,	10	55	10	55	10	55		
		Minimum,	11	10	11	5	11	10		
		Max.	11	35	11	25	11	30		
		Min.	11	40	11	30	11	35		
		Max.	11	50	11	35–40	11	45		
		Min.	12	0	11	50	11	55		
		Max.	12	15	12	5–10	12	15		
		Min.	12	35	12	30	12	35		
		Max.	13	45	13	40	13	45		
		Max.	14	15–20	14	15	14	15		
		Min.	15	0	15	0	15	0		
		Min.	15	50	15	45	15	50		
		Max.	15	55	15	55	15	55		
		Min.	16	25	16	10	16	20		
		Max.	16	35	16	35	16	35		
		Min.	16	45	16	45	16	45		
		Max.	17	0	16	55	17	0		
		Min.	17	15	17	5	17	10		
		Max.	17	25	17	15	17	20		
		Min.	17	35	17	30	17	30–35		
		Max.	18	5	18	0	18	5		
		Max.	20	35	20	30	20	30–35		

Table continued.

			Toronto.		Cambridge.		Philadelphia.		Washington.	
			h.	m.	h.	m.	h.	m.	h.	m.
1840.	May 30.	Max.	0	50–55	0	50	0	50		
		Min.	2	5	2	5	2	5		
		Max.	2	20	2	20	2	20		
		Max.	9	30	9	30	9	25		
		Min.	9	35	9	35	9	35		
	June 24.	Max.	16	40			16	35–40		
	June 25.	Min.	5	10			5	10		
	July 22.	Max.	16	25			16	25		
		Min.	19	0			19	0		
		Max.	19	20			19	20		
		Min.	19	40			19	40		
	July 23.	Max.	5	10			5	10		
	Aug. 28.	Max.	10	45–50	10	40–45	10	45		
		Min.	11	35	11	30–35	11	30–35		
		Max.	11	50	11	50	11	50		
		Min.	13	25	13	25	13	25		
		Max.	14	40	14	35–40	14	40		
		Min.	15	5	15	5	15	5		
		Max.	15	15	15	10	15	10		
		Min.	15	40	15	35	15	35		
		Min.	16	20–25	16	20	16	20		
		Max.	16	35	16	30	16	30		
		Min.	16	45–50	16	40	16	40–45		
		Max.	17	5	17	0	17	0–5		
		Min.	17	20	17	20	17	20		
		Max.	17	40	17	35	17	40		
		Min.	18	5	17	55	18	0		
		Max.	18	15	18	5	18	10		
		Min.	18	30	18	20	18	25		
		Max.	18	35	18	30	18	35		
		Min.	18	50	18	45	18	50		
		Max.	19	20	19	10	19	15		
		Max.	19	50	19	50	19	50		
		Max.	23	25	23	25	23	25		
	Sept. 23.	Max.	10	40	10	40	10	40	10	45
		Max.	13	50	13	40–50	13	50	13	55
		Min.	15	45–50	15	45	15	55	15	50
		Min.	22	50	22	50–55	22	50	22	50
	Sept. 24.	Min.	0	35	0	35	0	35	0	30
		Min.	2	15	2	15	2	15	2	15
		Max.	2	35	2	30	2	30–35	2	35
		Min.	4	30	4	30	4	30	4	35
	Oct. 21.	Max.	10	50	10	45	10	45	10	45–50
		Min.	11	10	11	5	11	5		
		Max.	14	50	14	50	14	50		
		Min.	15	15	15	10–15	15	15		
		Max.	16	0	16	0	16	0		
		Min.	16	35	16	25–30	16	30	16	35
	Oct. 22.	Min.	3	35	3	35	3	35		
	Nov. 28.	Max.	2	15	2	15	2	15	2	20
	Dec. 23.	Max.	11	45	11	45	11	45	11	45
		Max.	13	10	13	10	13	10	13	10
		Min.	13	25	13	25	13	25	13	25
		Max.	13	40	13	35	13	35	13	35
		Min.	14	20	14	15	14	15	14	15
		Max.	15	0	14	55	14	55–60	15	0
		Max.	15	20	15	20	15	20		
		Min.	18	50	18	50	18	50	18	50
		Max.	22	30	22	20	22	20–25	22	20–25

Table continued.

			Toronto.		Cambridge.		Philadelphia.		Washington.	
			h.	m.	h.	m.	h.	m.	h.	m.
1840.	Dec. 24.	Max.	1	30	1	30	1	30		
		Max.	2	55	2	55	2	55		
		Min.	3	5	3	5	3	5		
1841.	Jan. 20.	Max.	15	25	15	25	15	25		
	Jan. 21.	Min.	7	5	7	5	7	5	7	10
		Min.	8	50	8	50	8	50	8	50–55
	Feb. 26.	Max.	13	15	13	15	13	15	13	15
		Min.	13	50	13	40–50	13	50	13	50
		Max.	15	10–15	15	10	15	10	15	10
		Min.	15	35	15	30	15	30	15	30
		Max.	16	0–5	15	55–60	16	0	16	0
		Min.	21	30	21	30	21	30	21	30
	March 24.	Max.	12	5	12	0	12	5		
		Min.	12	20–25	12	20	12	20–25		
		Max.	12	40	12	40–45	12	40		
		Min.	15	25–30	15	25	15	25		
		Max.	15	45–50	15	45	15	45		
		Max.	16	25	16	20	16	25		
		Min.	18	25	18	25	18	25		
	April 21.	Max.	11	15	11	15	11	15	11	15
		Max.	14	50	14	50	14	50	14	45–50
		Max.	15	20	15	15	15	20		
		Min.	15	30	15	30	15	30		
		Max.	15	45	15	40	15	45		
		Min.	15	55	15	55	15	55	15	55–60
		Min.	18	20	18	20	18	20		
	May 28.	Max.	12	25	12	20	12	20–25	12	25
		Max.	13	45–50	13	45	13	45	13	50
		Min.	14	15	14	15	14	15	14	15
	June 23.	Max.	10	40	10	40	10	40	10	40
		Max.	12	10	12	10	12	10		
		Min.	19	10	19	5–10	19	10		
		Min.	23	15	23	10–15	23	15		
	June 24.	Max.	1	40	1	40	1	40		
		Min.	3	45	3	45	3	45		
	July 21.	Max.	14	35	14	30–35	14	30–35	14	35
		Min.	14	55	14	50	14	50	14	50
		Max.	15	25	15	20	15	25	15	25
		Min.	16	15	16	10	16	10–15	16	10–15
		Min.	17	45–50	17	45–50	17	50	17	50
		Min.	19	10–15	19	15	19	10–15	19	15
		Max.	20	0	19	55	20	0		
		Min.	21	15	21	15	21	15	21	15
	July 22.	Min.	3	40	3	40	3	40	3	35
	Aug. 27.	Min.	10	50	10	50	10	50	10	50
		Min.	12	55	12	50	12	50		
		Max.	13	15	13	15	13	15	13	15
		Max.	14	55	14	55	14	55	14	55
		Max.	17	30	17	25	17	25–30	17	30
		Min.	18	20	18	20	18	20	18	20
		Max.	19	30	19	25	19	30	19	30
	Aug. 28.	Max.	1	35	1	30–35	1	35	1	35
		Min.	7	40	7	35–40	7	40	7	40
	Sept. 22.	Max.	18	40	18	40	18	40		
	Sept. 23.	Min.	0	30	0	30	0	30	0	30
		Min.	3	10	3	10	3	10	3	10
	Oct. 20.	Max.	14	50	14	45	14	45	14	45–50
		Max.	18	45	18	40	18	45	18	45
		Min.	19	0	18	55	19	0	19	0
		Max.	19	10	19	5	19	5	19	5

Table continued.

			Toronto.		Cambridge.		Philadelphia.		Washington.	
			h.	m.	h.	m.	h.	m.	h.	m.
1841.	Oct. 20.	Min.	19	30	19	30	19	30		
		Max.	19	50–55	19	50	19	50	19	50–55
		Min.	22	5	22	5	22	5		
	Oct. 21.	Min.	0	5	0	5	0	5	0	5
		Max.	3	10	3	10	3	10	3	10
	Nov. 26.	Max.	14	40	14	35–45	14	30–40	14	40–45
	Dec. 22.	Min.	20	5	20	5	20	5	20	5
		Min.	22	15–20	22	15–20	22	15–20		
1842.	Jan. 19.	Max.	12	24	12	20	12	24		
		Max.	16	42	16	40	16	42		
		Min.	17	12–18	17	15	17	12–18		
	Feb. 25.	Min.	11	36	11	30	11	30		
		Max.	12	0–6	12	0	12	0–6	12	5–10
		Max.	15	0	15	0	15	0	15	0
		Min.	19	42–48	19	45	19	42–48	19	45
	Feb. 26.	Min.	0	0	0	0	0	0	0	0
	March 23.	Max.	13	0	13	0	13	0	13	0
		Min.	14	12	14	10	14	12	14	15
		Max.	17	12–18	17	15	17	18	17	15
	March 24.	Max.	4	0	4	0	4	0	4	0
		Min.	8	36	8	35–40	8	36	8	30–35
	April 20.	Max.	13	30	13	30	13	30	13	30
		Min.	14	0	14	0	13	54	14	0
		Min.	15	48	15	50	15	48–54	15	50
		Max.	16	24–30	16	20–25	16	24	16	25
		Max.	19	30	19	30	19	30	19	30
		Min.	19	48–54	19	55	19	54	19	55
	April 21.	Max.	6	0	6	0	6	0	6	0
	May 27.	Max.	14	54–60	14	55	14	54	15	0
		Max.	19	24–30	19	25–30	19	24–30	19	30
	June 22.	Min.	14	18–24	14	20	14	18	14	20
		Max.	15	6	14	55	15	6	15	5
		Max.	16	42	16	40–45	16	42	16	45
		Max.	17	18	17	15	17	18	17	20
		Max.	17	54–60	17	50	17	54	17	55
		Max.	19	36–48	19	30	19	36–42	19	45
		Max.	20	36	20	35	20	36	20	35
	June 23.	Max.	0	0	0	0	23	54–60	0	0
		Max.	8	36	8	35	8	36	8	40
	July 20.	Max.	13	18	13	15	13	18		
	Aug. 26.	Max.	11	48–54	11	45	11	48		
		Max.	14	18	14	10	14	12		
		Min.	14	30	14	25	14	30		
		Max.	15	36	15	30	15	30		
	Aug. 27.	Min.	4	0	3	55	3	54		
	Sept. 21.	Min.	12	54–60	12	55	12	54		
		Max.	13	30	13	20–25	13	24		
		Max.	17	54	17	45–50	17	48		
		Min.	19	24	19	15	19	18		
		Max.	21	54–60	21	55	21	54		
	Sept. 22.	Max.	4	0	3	55	3	54		
		Max.	8	12–18	8	10	8	12		
	Oct. 19.	Max.	13	30	13	25	13	24		
		Min.	18	0–6	18	0	18	0		
		Max.	21	24	21	25	21	24		
		Max.	22	24	22	25	22	24		
	Oct. 20.	Max.	0	30	0	30	0	30		
	Nov. 25.	Max.	15	18	15	15	15	18		
	Dec. 21.	Max.	14	48	14	45	14	48		
		Max.	17	48–54	17	45–50	17	48		

The following table shows in how many cases the maximum deviation of the magnetic needle occurred earlier at Cambridge, Philadelphia or Washington than it did at Toronto; in how many cases it occurred at the same instant; and in how many cases it occurred later than at Toronto. From May, 1840, to Dec. 1841, the observations at each station were made at intervals of 5 minutes; but in 1842 the observations at Toronto and Philadelphia were made at intervals of 6 minutes. The differences therefore in the times of maximum deviation are generally 0, or 5 or 10 minutes; but when at one of the stations the indications of the needle were sensibly the same at two successive observations, we may obtain differences of 2½ or 7½ minutes. In the few cases in which other differences are obtained, they have been classed with the numbers in the table to which they approached nearest.

Maximum deviation of the magnetic needle.

	Cambridge.	Philadelphia.	Washington.
12½ minutes earlier,	2		
10 " "	7		
7½ " "	6	1	1
5 " "	34	19	2
2½ " "	16	25	7
At the same instant,	44	70	28
2½ minutes later,	2	1	7
5 " "			5
Average result,	$3^m{\cdot}11$ earlier.	$1^m{\cdot}40$ earlier.	$0^m{\cdot}15$ later.

These observations indicate that the maximum deviation of the magnetic needle advances like a wave over the earth's surface; and that the direction of its motion is from N. 68° E. to S. 68° W. A comparison of the Cambridge and Toronto observations indicates a velocity of progress amounting to 113 miles per minute; while a comparison of the Philadelphia and Toronto observations indicates a velocity of only 75 miles per minute.

The following table shows in how many cases the minimum deviation of the magnetic needle occurred earlier than at Toronto; in how many cases it occurred at the same instant; and in how many cases it occurred later than at Toronto.

Minimum deviation of the magnetic needle.

	Cambridge.	Philadelphia.	Washington.
15 minutes earlier,	1		
10 " "	6		
7½ " "	2		
5 " "	17	18	5
2½ " "	12	8	2
At the same instant,	40	56	21
2½ minutes later,	4	3	7
5 " "	1	0	3
7½ " "		1	
Average result,	$2^m{\cdot}29$ earlier.	$1^m{\cdot}10$ earlier.	$0^m{\cdot}04$ later.

These observations indicate that the minimum deviation of the magnetic needle advances like a wave over the earth's surface; and that the direction of its motion is from N. 69° E. to S. 69° W. A comparison of the Cambridge and Toronto observations indicates a velocity of progress amounting to 156 miles per minute; while a comparison of the Philadelphia and Toronto observations indicates a velocity of only 103 miles per minute.

We thus see that the average progress of the maxima and minima deviations of the magnetic needle was very nearly in the same direction and with the same velocity. Assuming that the average direction of both classes of waves is the same, we find their progress to be from N. 68° E. to S. 68° W.; and the velocity of their progress deduced from a comparison of the Cambridge and Toronto observations is 134 miles per minute; while the velocity deduced from a comparison of the Philadelphia and Toronto observations is 89 miles per minute.

In my former article, p. 334, I found that in Central Europe, the deflections of the magnetic needle were propagated in a direction from N. 28° E. to S. 28° W. Mr. C. V. Walker determined that the direction of this motion in England was from N. 42° E. to S. 42° W.; and we now find this direction in the neighborhood of New York to be from N. 68° E. to S. 68° W.

At the time of a considerable number of the preceding observations, auroras were recorded at some one of the stations. The following are the auroral notices at Toronto, corresponding to some of the preceding dates. The dates are all given in the mean time of Göttingen.

Auroral observations at Toronto.

1840. May 29. 15^h. Faint light in north.

$15^h\ 16^m$, faint streamers shot up from N.E. to altitude 60°; a most brilliant aurora followed.

16^h, aurora most brilliant.

$16^h\ 5^m$, a perfect arch from N.W. to N.E. Splendid streamers rising from it, and almost a continued gleam of light from the incessant flashes or pulsations.

17^h. Streamers disappeared; faint patches of light and a few pulsations.

18^h. Very faint light arch, dark clouds rising in N. horizon.

19^h. Bright aurora.

20^h. Bright aurora.

Aug. 28. $14^h\ 30^m$. Splendid aurora.

15^h. Aurora visible at intervals.

$17^h\ 30^m$. Aurora very splendid.

18^h. Auroral light obscured by the clouds.

19^h. Overcast.

21^h. Cleared up; aurora again visible.

1840. Oct. 22. From 15^h to 18^h faint auroral light.
Dec. 23. 17^h. Bank of auroral light in N.; faint streamers.
18^h. Auroral light in N. Patches of light and streamers.
19^h. Faint auroral light in N.
1841. April 21. 15^h. Auroral light in N. horizon; a few faint streamers rising from it.
20^h. Faint auroral light to N.
July 21. 17^h 30^m. Bright bank of auroral light in N.
19^h. Faint auroral light in N.
20^h. Faint auroral light in N.
21^h. Faint auroral light in N.
Oct. 20. 14^h 35^m. Auroral light in N.
15^h 20^m. Very faint auroral light along N. horizon.

The following notices of the aurora were recorded at Washington. The dates are given in the mean time of the place.

Auroral observations at Washington.

1840. Aug. 28. From 8^h 30^m to 9^h 45^m P. M. the aurora distinctly visible, extending from N.E. by N. to N.W. by N.; faint appearances of it at irregular intervals, until 1^h 45^m A. M. of 29th.
Sept. 23. At 10^h 40^m P. M. a segment of an auroral arch, extending from N.N.E. to N.N.W.; centre or highest point, N. by E.; altitude 8°.

The following auroral notices are from the register kept at New Haven by Mr. E. C. Herrick.

Auroral observations at New Haven.

1840. May 29. A conspicuous aurora. A narrow belt overhead between 9^h and 10^h; and after 10^h auroral waves as high as zenith.
Aug. 28. A considerable aurora visible. An arch 40° high in N. between 10^h and 11^h. Few streamers.
Oct. 22. A distinct aurora. An arch 2° or 3° high lying 30° or 40° along the northern horizon.
Dec. 24. During most of the evening there seemed to be a faintly luminous vapor, particularly in the N., but also more or less elsewhere.
1841. March 24. An auroral arch low in N. horizon all evening; about 2° high; bright. I saw no streamers.
July 21. A faint auroral illumination at 10 P. M. and also at 2 A. M. of the 22d.
Oct. 21. About 1 A. M. a brilliant auroral display, not extending higher than 40°; streamers rapidly shifting.
1842. April 20. Slight aurora about 11^h, and faint traces through the night.

If now we make the comparison for those dates at which an aurora was recorded at Toronto, we shall find that the maxima and minima deviations of the magnetic needle occurred at Cambridge on an average $3^m \cdot 88$ earlier than at Toronto, and at Philadelphia $1^m \cdot 87$ earlier than at Toronto. These results are a little greater than those obtained from a comparison of all the observations, and indicate a motion somewhat more nearly east and west; but the general character of the results is the same. We seem authorized then to infer that *in the eastern part of the United States the irregular deflections of the magnetic needle, whether attended or not by any auroral exhibition, are generally propagated in a direction from N.* 68° *E. to S.* 68° *W., and with an average velocity of about* 112 *miles per minute.*

During the exhibition of brilliant auroras, auroral beams do not ordinarily continue stationary for many minutes. They generally exhibit a movement of translation towards the south, and frequently also a movement to the east or west of the meridian. In order to determine whether there is any uniformity in the direction of this motion, I have collected together all the notices of this kind which I could find recorded in the Am. Journal of Science, in the Reports of the N. Y. Regents, and in various other works. The following is the result of this examination.

Notices of lateral displacement of the auroral beams.

From the American Journal of Science.

Vol. xiv, p. 92. 1827, Aug. 28. New York City. Waves of light began to flow from the eastern toward the western part of the luminous arch. The whole arch moved towards the south.

Vol. xiv, p. 94. Troy, N. Y. The flowing of the light from E. to W. was constant.

Vol. xiv, p. 104. Canandaigua, N. Y. About the time that the arch broke up into columns, it seemed to move back towards the north. Soon after it moved again to the south, apparently with a more rapid motion than ever.

Vol. xiv, p. 105. 1827, Sept. 9. Canandaigua, N. Y. A light cloud, moved gently to the west, and gradually put on the appearance of beams of light. Proceeding still west, and probably a little south, they seemed to lengthen and descend toward the western horizon. The movement westward was distinct, but not sufficiently so to enable me to estimate the rate of motion.

Vol. xiv, p. 106. Ib. The western motion of the fragments was perceptible, and was estimated at four degrees in thirty-two seconds.

Vol. xxvii, p. 113. 1833, May 17. Philadelphia, Pa. This arch passed gradually towards the south.

Vol. xxvii, p. 119. 1833, July 10. Philadelphia. Four beams were visible; the last beam vanishing after appearing to move westward.

Vol. xxix, p. 389. 1835, Nov. 17. New Haven, Conn. The zone moved slowly to the south, until about 9 o'clock. From this time it began to recede northward.

Vol. xxx, p. 135. 1835, Dec. 11. Toronto, Canada. All these rays moved in a very stately march from east to west.

Vol. xxx, p. 231. 1835, Sept. 4. New Haven, Conn. The streamers all moved to the east about 6°. Beams shot up about 30° high, and moved laterally to the east.

Vol. xxxii, p. 178. 1837, Jan. 25. New Haven. The twilight of the northern sky moved slowly southward.

Vol. xxxii, p. 221. 1836, Aug. 12. Ib. Over head the arch moved southward. In the east it also advanced southward.

Vol. xxxii, p. 222. Ib. Parallel fleeces, distinct from each other, were in slow motion toward the west.

Vol. xxxii, p. 225. 1836, May 8. New Haven. The arch advanced southward.—The bow moved slowly south.—The arch had advanced southward.

Vol. xxxii, p. 394. 1836, May 8. Toronto, Canada. A shining broad column of light passed very slowly and bodily to the westward.

Vol. xxxiii, p. 212. 1837, July 29. Burlington, Vt. A luminous arch moved slowly to the south.

Vol. xxxiv, p. 275. 1837, Nov. 14. Geneva, N. Y. A bright white streamer passed the north star, on its way to the west.

Vol. xxxviii, p. 262. 1839, Sept. 3. Nashville, Tenn. A westward motion was observed in three principal columns.

Vol. xxxviii, p. 376. 1839, Sept. 3. Middlebury, Vt. The belt moved south—rapidly at first, then more slowly.

Vol. xxxix, p. 194. 1840, May 29. New Haven. The belt drifted southward at the rate of about a degree per minute.

Vol. iii, n. s., p. 440. 1847, April 7. New Haven. The auroral belt moved southward from 77° above the N. horizon to 65° above the southern.

Vol. xiii, n. s., p. 427. 1852, Feb. 19. New Haven. Streamers began to shoot upward, having a horizontal movement from E. to W.

Vol. xiv, n. s., p. 131. 1852, April 22. New Haven. The whole beam slowly moved southward.

Vol. xxviii, n. s., p. 391. 1859, Aug. 28. New Haven. Auroral arch advanced 18° toward the south in fifteen minutes.

Vol. xxviii, p. 394. 1859, Aug. 28. West Point, N. Y. A yellowish cloud advanced southward with an even boundary.

Vol. xxviii, p. 394. Ib. The streamers in the north were numerous and were perceived universally to move towards the west.

Vol. xxviii, p. 395. Ib. The entire expanse of cloud in the south was making a similar progress west, at the rate of forty degrees in about two minutes. At 3 A. M. the streamers in the north moved across the constellation Cassiopea from west to east, contrariwise to the motion in every instance I have before observed in any aurora.

Vol. xxviii, p. 396. Ib. The southern streamers were also moving to the east.

Vol. xxviii, p. 404. 1859, Sept. 2. Havana, Cuba. The summit of the arch had a movement of translation toward the east. A brightness streamed from the north, moving towards the N.N.E.

Vol. xxviii, p. 406, Ib. Reiterated movement of translation of the whole aurora from E. to W., followed by a retrocession in the opposite direction.

Vol. xxix, p. 252. 1859, Aug. 28. Halifax, N. S. The streamers appeared to work from W. by N. to south. I think they worked along from E. to W., but another observer said from W. to E.

Vol. xxix, p. 257. 1859, Aug. 28. Steubenville, Ohio. At 7½ P. M. the aurora moved to the south. At 9 P. M. the light advanced again and passed clear to the south as before.

Vol. xxix, p. 258. 1859, Aug. 28. Burlington, N. J. An arch of light rose in the north, passed the zenith, and descended to within about 20° of the south horizon.

Vol. xxix, p. 260. 1859, Aug. 28. Sacramento, Cal. Lambent streamers were noticed to shift gradually from west to east and vice versa.

Vol. xxix, p. 263. 1859, Aug. 28. Galveston, Texas. Stately columns of light reaching up about 45° from the horizon, moved westward about one degree for every ninety seconds of time.—The columns drifted westward and faded.

Vol. xxx, p. 86. 1859, Aug. 28. Cleveland, Ohio. Bright rays suddenly shot up in quick successive flashes, reaching nearly to the zenith, and moving slowly to west.

Vol. xxx, p. 87. 1859, Sept. 1. Fort Bridger, Utah Ter. The light appeared to flow gradually from N.N.E. to the southern sky.

Vol. xxx, p. 345. 1859, Aug. 28. Gettysburgh, Penn. The streamers were visibly wafted round on the east and west to the S.E., S.W., and even south.

From New York Meteorology 1826–1850, *by Franklin B. Hough.*

Page 487. 1827, Aug. 28. Lowville, N. Y. The arc began to move in a southern direction....it broke up into parallel pieces which moved majestically westward.....At 11 its motion was mainly south.

Page 487. 1827, Aug. 28. Pompey, N. Y. The arc gradually inclined towards the south.

Page 488. 1830, July 15. Fredonia, N. Y. A belt at right angles with the galaxy, moved towards the south.

Page 489. 1831, April 1. Albany, N. Y. Shot up into brilliant columns moving eastward.

Page 489. 1831, April 19. Utica, N. Y. A beautiful arc, elevated about 50°, gradually rose, passed the zenith, and descended into the south within 25° of the horizon.

Page 489. 1831, June 21. Albany, N. Y. Shot up into brilliant prismatic columns which moved from W. to E., preserving in their motion a parallel position. In one or two instances, a sudden and rapid motion in the opposite direction towards the west.

Page 489. 1831, July 3. Albany, N. Y. Shot up into columns which appeared to move slowly in some cases to the east.

Page 490. 1831, July 31. Johnstown, N. Y. An arch moved south about 20°.

Page 490. 1833, May 17. Johnstown, N. Y. Parallel columns of light moved rapidly from N. to S.

Page 491. 1835, Sept. 9. Albany, N. Y. A faint white arch in the northern hemisphere which moved towards and passed the zenith.

Page 491. 1836, April 12. Cazenovia, N. Y. A single beam from the horizon moved sensibly to the south.

Page 493. 1837, Nov. 14. Buffalo, N. Y. Red streams further east appeared moving slowly eastward.

Page 493. 1837, Nov. 14. St. Lawrence, N. Y. Tall columns of silvery light were seen in the northern horizon, sometimes shooting up to the zenith, and again moving slowly from E. to W. as if impelled by a gentle breeze.

Page 496. 1842, June 4. Rochester, N. Y. A fine arc rose N. of E. and moved southward.....Grew fainter, moved slowly southwards, extended down to the horizon, began to move in slow portions to the west.

Page 497. 1847, March 19. North Salem, N. Y. Streamers ascended to the height of 20°; all of which had a slow motion to the eastward.

Page 497. 1847, March 19. Woodstock, Vt. Pillars moving sometimes eastward and then westward, and sometimes rapidly passing each other.

Page 498. 1847, Nov. 25. North Salem, N. Y. A few streamers rose to the height of 45°, having a slow motion westward.

Page 498. 1848, April 1. Rochester, N. Y. Luminous white pillars; white pencils in the N.E. gradually passing westward and vanishing west of north.

Page 498. 1848, April 6. New York City. Streamers shooting up and moving westward.

Page 499. 1849, March 18. North Salem, N. Y. Streamers shot up: at first generally white; occasionally a tinge of red. The whole had a slow motion to the west.

From Arago's Meteorological Essays.

Page 448. 1827, Aug. 27. New York. A great number of bright streamers, which underwent a very rapid horizontal or lateral movement from east to west.

Page 449. 1827, Aug. 28. New York. There were in the north two concentric arches. The upper arch rose gradually higher above the horizon; reached the zenith; passed beyond it and then broke up. Vertical columns of light, having rather a rapid movement of translation, carrying them from E. to W., showed themselves below the great arch.

From newspaper records.

1835, Nov. 18. Hanover, N. H. Very brilliant streamers appeared to chase each other, running rapidly from W. to E. and back again from E. to W.

1839, Sept. 3. Middlebury, Vt. The auroral belt moved south, rapidly at first, then more slowly. Five parallel streamers, about 3° long, moved to the west, but not so rapidly as to be directly seen in motion.

1839, Sept. 14. Middlebury, Vt. There were seen in the arch prismatic streamers in active motion. Some of the motions were from west to east.

1841, Nov. 18. New Haven, Conn. There were two zones in the north, and columns slowly moving eastward.

From the Record of Auroral Phenomena by Peter Force.

Page 37. 1821, April 27. Fort Enterprise, lat. 64½°, long. 113° W. A single column of aurora rose in the north, and traversed the zenith towards the south. It passed to the western horizon in ten minutes.

Page 42. 1820, Dec. 4. Ib. A broad arch passed gradually to the southward.....A bright arch had a direction from N. to S.....A well formed arch moved slowly to the southward.

Page 44. 1820, Dec. 11. Ib. The arches moved slowly to the southward.

Page 62. 1850, Jan. 1. Fort Franklin, lat. 65°, long. 123° W. The aurora changed its position, progressing regularly and gradually towards the south.

Page 102. 1820, Feb. 10. Winter Harbor, lat. 74½°, long. 110° W. A low arch to the westward, from which pencils appeared to proceed. These pencils had a slow, though very sensible, lateral motion from north to south and vice versa.

The preceding catalogue includes 36 cases in which the motion of auroral arches and beams was described as from N. to S., and only three cases of a motion from S. to N. In the aurora of Aug. 28, 1827, at Canandaigua, N. Y., the arch seemed to move back towards the north; and soon after it moved again to the south more rapidly than ever. In the aurora of Nov. 17, 1835, at New Haven, the auroral zone, after moving for some time toward the south, began to recede northward; and also in the aurora of Feb. 10, 1820, at Winter Harbor, the auroral pencils had a slow lateral motion from N. to S. and vice versa.

We may hence conclude that in the United States, great auroras almost invariably exhibit a motion from N. to S. with occasionally and temporarily a slight retrograde movement from S. to N.

The preceding catalogue includes 31 cases in which the motion of auroral beams was described as from E. to W.; and 15 cases of a motion from W. to E. If auroral streamers had a motion exactly from N. to S. then those streamers which were included between the N. and E. points of the horizon would have an apparent motion towards the E.; while those streamers which were included between the N. and W. points of the horizon would have an apparent motion towards the west. It seems probable that the apparent motion from E. to W. and from W. to E. is frequently due to an actual motion from N. to S.; but since the apparent motion towards the W. is twice as frequent as that towards the E. we must conclude that *the actual motion of the streamers is from about N.N.E. to S.S.W.*

We thus find a general correspondence between the direction of the electric currents which traverse the earth's surface during displays of the aurora, and the motion of the auroral beams. In the United States, the former move from about N. 68° E. to S. 68° W., while the latter move from about N. 30° E. to S. 30° W.

ART. V.—*Observations on the Saltwaters of the Alleghany and Keskeminetas Valleys;* by Dr. EDWARD STIEREN.

I. *Preliminary remarks.*

WITHIN a distance of about 35 miles above the city of Pittsburgh there have been bored, on both sides of the Alleghany and Keskeminetas rivers, more than thirty saltwells, the greater part of which are used for the manufacture of common salt.

These valleys belong to the coal period and the strata have a gentle dip to the southwest. There is no rock-salt, and no deposits of gypsum have ever been found in this district.

In boring these wells we pass through sandy shale, fire-clay, limestones, and different kinds of marl and clay-slates, through porous, white and red sandstone in strata of various thickness, and several veins of bituminous coal, from two to seven feet in thickness. One of these sandstones is from 70 to 100 feet in thickness, and is usually found at a depth of from 200 to 250 feet; this rock contains small quantities of carbonate of lime, baryta and strontia.

These mineral waters are, we believe, formed by the percolation of meteoric waters through the superincumbent beds of marls and clays, from which, assisted by the carbonic acid received from the atmosphere, and by pressure, they dissolve saline matters till an impenetrable stratum is reached, where they remain, saturating the porous sandstone and filling the fissures of the surrounding beds.

The wells are from 400 to 1200 feet deep, and from 3 to 3½ inches in diameter, and are lined with copper pipes.

An examination of many of the brines of the Alleghany and Keskeminetas valleys during a series of years past has convinced me that, as respects their chemical constituents, they are among the most interesting cold saline mineral waters, which have as yet been analyzed. Several of these wells yield, besides salt water, a very superior quality of petroleum, which has been introduced into commerce, and for many years used for medical, illuminating, and lubricating purposes. They also give off an inflammable gas.

These brines are qualitatively all alike, but not in the quantities of their constituents. Their specific gravities are from 1·0175 to 1·098, that is from 2½ to 13 degrees of Beaumé's hydrometer.

The brines of all the saltworks of both valleys, are without exception pumped by steam power. A yellowish colored sediment, which by degrees becomes red, is deposited in the spouts, in which the brine is carried from the pump to the boiling pan, but in the boiler itself a much larger quantity of the yellow-reddish sediment is precipitated, which becomes when exposed to the air for a few days, of a deep red color. The natural brine when boiled down to a specific gravity equal to from 1·124 to 1·160, (=16 to 20° B.) is then drawn off into a wooden cistern, where it is mixed with a thin lime-milk, and well stirred. After clearing, this brine is drawn off or pumped into the grainers where after the well known process the salt is obtained either fine or coarse. Both pans are heated by the same fire and so placed that the grainer is behind the boiler. Bituminous coal is exclusively used as fuel.

During a period of four years I have analyzed quantitatively brine from several wells of the Alleghany and Keskeminetas Valleys, but I shall here give only the analysis of water which was obtained from the salina of Mr. Peterson, in the vicinity of Tarentum.

II. *Physical properties.*

When freshly pumped this saltwater appears turbid, owing to petroleum which is suspended in it, though after standing a little while it becomes clear and the petroleum floats on the surface, forming a scum, thicker or thinner, according to the proportion of petroleum which is contained in the brine, which is of a reddish-yellow color. Its taste is saline, afterwards bitter, and it smells slightly of petroleum. The average specific gravity, from my experiments, is found to be equal to 1·0352, at +18·5° C. The temperature of the water is equal to 17·5° C., at 20° temperature of the atmosphere. If exposed to the air, the water by degrees becomes turbid from loss of gas (CO^2) and deposits a dirty yellow-colored precipitate, on the sides and bottom of the beaker-glass, changing after a few days to a reddish-yellow color, a change hastened by boiling.

III. *Chemical properties.*

A. *Qualitative Analysis.*

The solid constituents of this water are divided into two classes, like those of almost all other brines.

1. Such as are of themselves insoluble in water, and which are kept in solution by the free carbonic acid.

2. Such as are soluble in water.

a. *Properties of the fresh water.*

1. Blue and red paper, and fresh prepared tincture of litmus, are not in the least changed.

2. Strips of paper moistened with a solution of acetate of lead were not at the least changed to a blackish or gray color, but became covered with a pure white powder.

3. Basic nitrate of bismuth suspended in the water retained its pure white color.

4. When the gas obtained by boiling the water is conducted into a solution of sugar of lead, acidulated with acetic acid, no change of color, and no precipitate is produced in the lead solution.

5. The gas obtained by boiling the water reddened litmus paper instantly, but not permanently. The same gas conducted into limewater caused a strong turbidness, and afterwards produced a precipitate which, while effervescing, was perfectly soluble in muriatic acid.

6. The addition of acids produced a slight escape of air bubbles.

7. Sulphuric acid produced a strong turbidness and quickly caused a precipitate which when repeatedly boiled with water was resoluble, leaving a very small quantity of a white sediment. This sediment proved to be baryta when treated before the flame of the blowpipe, and particularly when some chlorate of potash was added; the changing color of the flame satisfied me that the sediment also contained strontia.

8. Lime-water made the brine turbid, but by adding an excess of the latter the mixture became clear again.

9. Sesquichlorid of iron produced a red-brown tint.

10. Caustic ammonia produced a dirty white precipitate, which was partly soluble in a solution of salammoniac.

11. The carbonates of potassa and ammonia produced permanent whitish precipitates.

12. Chlorid of barium produced a strong turbidness, which by adding diluted nitric acid disappeared, air bubbles being expelled.

13. Oxalate of ammonia produced a copious white precipitate.

14. In the liquid filtered from the precipitate of 13 a crystalline precipitate was formed by the addition of caustic ammonia and phosphate of soda.

15. Nitrate of silver produced a copious, white, caseous precipitate, soluble in caustic ammonia, and giving an opalescent liquid. Nitric acid had but a very slight effect upon the precipitate.

16. Gallic acid produced, after some standing, a violet tint.

17. Tannic acid produced, after some standing, a reddish-violet tint.

18. Ferrocyanate of potassa produced, after standing, a slight bluish tint.

19. Sesquiferrocyanate of potassa produced, after standing, a greenish tint.

20. Hydrosulphuret of ammonia produced, after standing, a greenish tint.

21. When some of the brine was slightly acidulated by muriatic acid, and some of the reagents mentioned under 16 to 20 added to it, then the different tints were produced instantly. In No. 20 was formed, after a few hours, a blackish precipitate, in voluminous flocks.

22. A solution of gypsum produced in the brine, when slightly acidulated with nitric acid, a marked turbidness, which after a few hours settled into a precipitate. This precipitate, when washed with water and dried, and treated before the flame of the blowpipe, showed to be a mixture of strontia and baryta.

23. The chlorids of platinum and gold, had not the slightest effect on the fresh brine.

24. Chlorid of palladium produced in the brine, after the latter had been slightly acidulated with nitric acid and after standing for a short

time, a brown turbidness, which soon settled to the bottom in form of flakes of a blackish color.

25. Molybdate of ammonia had no effect upon the brine, either in the cold nor by boiling it, after being acidulated with nitric acid.

26. Chlorid of lime produced a brown turbidness, and after standing a good while longer, a voluminous precipitate of the same color.

27. When the brine was mixed with strong chlorine-water and a little carbonate of soda, a white turbidness was produced, which by heating increased, turning to a yellow color.

b. *Properties of the brine after heating.*

About 40 pounds of the fresh brine were put into a large porcelain dish and brought cautiously and by degrees nearly to the boiling point and evaporated, until salt crystals made their appearance, besides the reddish-yellow powder obtained soon after the commencement of the evaporation. The sediment together with the liquid was put upon a filter, and the first was edulcorated with pure water, and then dried. The filtered solution was marked *a a*, and the dried precipitate *b b*.

a. a. *The solution, or the filtrate* a. a. *was subjected to the following experiments.*

1. Reaction perfectly neutral.

2. Caustic ammonia produced a voluminous and perfectly white precipitate, entirely soluble in a solution of salammoniac.

3. Carbonate of potassa produced a perfectly white precipitate, which increased when the mixture was boiled.

4. Chlorid of barium produced no change.

5. Oxalate of ammonia produced a copious white precipitate.

6. By adding to the liquid, filtered from the precipitate of No. 5, caustic ammonia and phosphate of soda, and then stirring it well, a crystalline white precipitate was obtained.

7. Nitrate of silver produced a white precipitate with a slight yellowish tint. This precipitate when mixed with nitric acid and well stirred and filtered, and submitted to a slow and very careful neutralization with caustic ammonia, no yellow precipitate could be produced.

8. Gallic and tannic acid, ferrocyanate and sesquiferrocyanate of potassa, and hydrosulphuret of ammonia, did not change the solution in the least.

9. Some of the liquid by evaporation was more concentrated and after cooling mixed with an alcoholic solution of platinum-chlorid, by which a yellow precipitate was obtained. To prevent errors, a second portion of the liquid, of which the alkaline earths were precipitated by carbonate of soda, the mixture evaporated almost to dryness, then again treated with water, filtered, and the solution so obtained concentrated again by a slow evaporation. By adding to this solution a small quantity of a spirituous solution of chlorid of platinum, a lemon-colored precipitate was also produced, which consisted of a combination of chlorid of potassium and of platinum, together with a combination of chlorid of ammonium and of platinum.

10. Another part of the filtrate was evaporated almost to dryness, and by heating it in a test tube, with a concentrated solution of caustic po-

tassa, a gas was expelled which turned curcuma paper brown, and which formed white vapors when a glass-rod moistened with muriatic acid was brought in contact with the gas. The same was also the case when the brine was acidulated with muriatic acid and evaporated to dryness, and then treated exactly as before mentioned.

11. A solution of gypsum produced a strong turbidness which soon settled as a precipitate, this was entirely insoluble in nitric acid. The precipitate well edulcorated was treated with carbonate of potassa and melted in a silver crucible, then the melted mass soaked in water. The insoluble matter was collected upon a filter and well washed, then dissolved in muriatic acid; the solution obtained evaporated to dryness, and the dry salt treated with alcohol, in which a portion of it was dissolved. The spirituous solution contained chlorid of strontium, and the parts insoluble in alcohol consisted of chlorid of barium.

12. A portion of the filtrate was slightly evaporated, and the crystallized chlorid of sodium was separated from the concentrated liquid. This solution when shaken in a bottle with chlorine-water, became of an intense brownish-red color. By the treatment with ether this mixture became colorless, while the ether itself was colored.

When by a cautious evaporation of a somewhat larger quantity of the filtrate (a. a.) the chlorid of sodium was separated as much as possible and the concentrated liquid evaporated until completely dry, again dissolved in water, and the solution exsiccated in a temperature of from 120 to 130° C., and after this operation had been repeated eight times, then not the slightest trace of bromine could be detected.

13. One part of the solution (a. a.) was shaken with some fresh boiled starch, and some drops of nitric acid added, which turned the mixture instantly to a deep dark blue color.

14. Another part of the solution was boiled with phosphate of silver; the liquid filtered from the chlorid of silver formed was evaporated to dryness. This dry salt was put in a test-tube, and some sulphuric acid added, and strongly heated in the alcohol flame, but no yellow-colored vapor escaped here, which would have colored yellow the stripes of paper saturated with solution of indigo, when brought in contact with them.

In another experiment some of the liquid was acidulated with concentrated sulphuric acid, and mixed with a saturated solution of sulphate of protoxyd of iron; but no darker tint of the mixture was produced.—Absence of nitric acid.

15. Some of the solution was acidulated with muriatic acid, and then evaporated slightly. Curcuma-paper dipped into the liquid was not browned by it, but kept its natural color.—Absence of boracic acid.

16. To a part of the solution was added caustic potash-liquor in a slight excess, then heated and filtered. When a solution of salammoniac was added to the filtered liquid neither turbidness nor a precipitate was produced.—Absence of alumina.

17. In order to determine if the (boiled) brine contains *lithium*, a sufficient quantity of carbonate of soda was added to the remaining and larger quantity of the solution *a. a.* and then boiled. After the precipitated alkaline earths had been edulcorated with water, the filtered liquid was evaporated to dryness and the residue gently heated. In treating

this heated substance with water a turbid solution was obtained, which, after filtering, appeared clear and colorless; the contents of the filter consisted of magnesia. As caustic soda in the *cold*, and carbonate of soda *by boiling*, did not produce the slightest changes in the filtered solution, phosphate of soda was added to the bulk of the liquid and then evaporated to dryness. This exsiccated salt mass was soaked in water, in which it was dissolved, leaving only a very small quantity of light white powder. After the powder had settled in a high glass cylinder, and the cleared solution was removed, the powder was collected upon a filter, and well washed with water. The dried light powder was heated with perfectly pure carbonate of lime, the heated mass then several times boiled with water, filtered, and the contents of the filter washed. The lime of this alkaline-reacting solution was precipitated by oxalic acid. The oxalate of lime was well edulcorated, and the solution obtained evaporated to dryness and then heated, in order to decompose the oxalates. After heating, the remaining mass was soaked in water, and treated with muriatic acid, when some coal remained, which was removed by filtration. The colorless liquid evaporated to dryness left a small quantity of a whitish substance, which was put in a bottle with a glass stopper, and absolute alcohol poured upon it; the alcohol acted upon the substance for several hours, during which time the bottle was often shaken. One part of the filtered alcoholic solution was evaporated, by adding some water to it, and then redissolved. The solution obtained produced no action upon caustic soda and oxalate of ammonia, but by adding phosphate of soda and heating it in a test-tube a white turbidness was instantly produced. The other part of the alcoholic solution inflamed, burnt with a red flame.

These experiments seem to prove the presence of *lithion* in the salt water, in the shape of chlorid of lithium.

b. b. *Examination of the dried precipitate* (b. b.) *insoluble in water.*

1. This precipitate or sediment formed a reddish-yellow powder which had neither smell nor taste. By heating in a platina crucible its reddish-yellow color changed into a dark cinnamon brown, without carbonizing or giving any smell resembling that of burning organic substances, or changing moistened curcuma-paper into brown or reddening litmus-paper when brought near the mouth of the crucible. Some of the heated refuse, soaked in water, gave a solution which showed a strong alkaline reaction.

2. One part of the heated powder was put in a small glass retort, and a sufficient quantity of concentrated sulphuric acid gradually poured upon the same, the mixture was boiled for a while, and the vapors conducted by an adopter into water. It was observed that neither corrosion of the glass was perceptible, nor was any flake of silica to be seen in the water, not even after the solution was mixed with some ammonia and left standing for several days. The same was the case with the sediment which was separated from a sufficient quantity of brine by boiling, and which had not been washed with water. It was also used in the dry state, but was not heated. In neither of the experiments could fluorine be detected.

3. The rest of the dried precipitate (*b. b.*) was treated with muriatic acid in excess, in which it was dissolved, all but a small quantity of insoluble substance; the unfiltered solution was then evaporated to dryness and soaked in water adding to the liquid obtained some drops of nitric acid. The solution was filtered from the separated silica, which contained some alumina; the solution obtained was tried with reagents.

Caustic ammonia produced a dirty white precipitate.

Alkaline carbonate produced a permanent dirty white precipitate.

Chlorid of barium produced no change.

Oxalate of ammonia produced instantly a white precipitate.

To the liquid filtered from the precipitate last obtained caustic ammonia and phosphate of soda were added; by stirring this mixture with a glass rod, a crystalline precipitate was soon produced. Caustic potassa produced a dirty white precipitate, which partly disappeared by heating; by adding a solution of salammoniac to the filtered liquid, light white flakes were separated. A large part of the solution was mixed with a solution of gypsum, which produced a strong turbidness, which settling to a precipitate became by degrees clear. This precipitate collected upon a filter was well washed with water and dried, then melted in a silver crucible with carbonate of potassa, then soaked in water and washed upon a filter until a solution of chlorid of barium did not produce any change of the liquid which came from the filter. By treating the contents of the filter with diluted muriatic acid, and by adding some fluosilicic acid to the solution, the characteristic crystals of *baryta* were produced. The solution from which the crystals were obtained was evaporated to dryness. In testing the dry mass by the blowpipe the presence of *strontia* was easily and surely detected by the purple-red tint of the flame.

Sulphocyanid of potassium colored the liquid red.

Ferrocyanate of potassa produced a deep dark blue tint, and soon after a precipitate of the same color.

A clear filtered, concentrated solution of chlorid of lime, of the strength of 36 p. c. produced a small quantity of voluminous brown flakes.

Molybdate of ammmonia did not produce the slightest change in color.—Absence of phosphoric acid.

The greater part of the solution (*b b*, 3.) was subjected to an examination in order to ascertain if the brine contained a combination of *lithion* which would be insoluble in water, but all experiments proved that such was not the case.

The presence of *lithium* was indicated in experiment *a a*, 12; if not deceptive, seemed to render it probable that it might be found in larger quantities as chlorid of lithium in the mother-lye of our Salinas.

Several experiments were therefore made on a larger scale with the mother-lye, in order if possible to arrive at an approximate result for the natural brine.

Three pounds of mother-lye, (from Peterson's works,) of a specific gravity = 1·335, were mixed with a sufficient quantity of dried carbonate of soda, and evaporated; the desiccated mass heated, redissolved in water and filtered, and then treated according to *a a*, 17. This experiment was repeated six times with the greatest care and exactness.

By evaporating the last filtrate of each experiment a very small quantity of a residuum was obtained each time.

Caustic potash and oxalate of ammonia caused no changes whatever in the solution; but phosphate of soda produced by heating a strong white turbidness.

The very small quantity of the dry white substance, from the evaporating dish of five of those larger trials treated by the blowpipe flame, did not contain the smallest quantity of *lithium*.

The change produced by phosphate of soda proceeded from traces of magnesia; and the red tint which was observed in the alcohol-flame (*a a*, 17) must therefore have been deceptive.

[An examination of the mother-liquor from the Salinas by means of the Spectroscope in the Sheffield Laboratory failed to detect the least traces of the new metals caesium and rubidium.—*Eds.*]

The preceding preliminary trials show the saltwater to contain:—

Potassa,	Lime,	Chlorine,
Soda,	Magnesia,	Bromine,
Ammonia,	Alumina,	Iodine,
Baryta,	Protoxyd of iron,	Carbonic acid,
Strontia,	Protoxyd of manganese,	Silicic acid.

Sulphuric, nitric, phosphoric and boracic acid, organic substances, fluorine, and sulphur, are absent from the brine.

In reference to the bromine contained in the brine, it may be observed that it is combined with magnesium, as the experiment (*a a*, 12) proved satisfactory. And in the examination of iodine, I combine it with calcium.

A perfectly neutral iodid of calcium gives a clear and colorless aqueous solution; the same is the case with the iodid of magnesium.

The iodid of calcium is partly decomposed at a temperature of from 120 to 160° C. The refuse, of course, shows an alkaline reaction; if the turbid liquid is filtered, the solution evaporated, and the inspissated mass heated in a crucible, then the decomposition continued at a temperature increased by degrees from 150 to 160° C. expelling iodine, leaving the lime in the crucible, which still contains some iodine. By repeating this operation six or seven times, the combination of iodine and calcium can be entirely discharged.

The iodid of magnesium treated in the same manner is also decomposed, like the iodid of calcium, but the complete decomposition of the combination of magnesium takes place at a much lower temperature, and even in the 3d and 4th operation.

B. *Results of the quantitive analysis.*

1. *Total quantity of the solid constituents.*

From 113·40 grammes of brine 5·5 grammes solid matter was obtained, dried at 100° C. temperature = 4·85 per cent, that is,

in 1000 parts.	in one pound = 7680 grains.
48·50.	372·48 grains.

2. *The separate constituents of the saltwater accounted by themselves.*

	In 1000 parts.	In one pound = 7680 grains, are grains:
Chlorine,	27·077266	207·953404
Bromine,	0·098992	0·760258
Iodine,	0·069176	0·531271
Carbonic acid,	3·929016	30·174843
Silicic acid,	0·125000	0·960000
Sodium,	13·059202	100·294672
Potassium,	0·021290	0·163507
Ammonium,	0·002184	0·016773
Baryta,	0·007447	0·057192
Strontia,	0·104094	0·799442
Lime,	5·832120	44·790683
Magnesia,	1·570055	12·058022
Alumina,	0·018270	0·140313
Protoxyd of iron,	0·023928	0·183767
Protoxyd of manganese,	*traces.*	*traces.*
	51·938040	398·884147

3. *Statement of the constituents, in the state as contained in the brine.*

	In 1000 parts.	In one pound = 7680 grains, are grains:
Chlorine,	27·077266	207·953404
Bromine,	0·098992	0·760258
Iodine,	0·069176	0·531271
Carbonic acid,	3·929016	30·174843
Silicic acid,	0·125000	0·960000
Sodium,	13·059202	100·294672
Potassium,	0·021290	0·163507
Ammonium,	0·002184	0·016773
Baryta (as such),	0·002948	0·022640
(Baryta as) barium,	0·004036	0·030996
Strontia (as such),	0·041493	0·318666
(Strontia as) strontium,	0·053005	0·407078
Lime (as such),	1·549614	11·901035
(Lime as) calcium,	3·117665	23·943667
Magnesia (as such),	0·655495	5·034201
(Magnesia as) magnesium,	0·564284	4·333701
Alumina,	0·018270	0·140313
Protoxyd of iron,	0·023928	0·183767
Protoxyd of manganese,	*traces.*	*traces.*
	50·412864	387·170795

4. *Statement of the combinations which these constituents, mentioned in No. 2 and 3, might form in the saltwater.*

	In 1000 parts.	In one pound = 7680 grains, are grains:
Chlorid of sodium,	32·977783	253·269374
" potassium,	0·040702	0·312592
" ammonium,	0·006709	0·051525
" barium,	0·006121	0·047009
" strontium,	0·095876	0·736327
" calcium,	8·578099	65·879800
" magnesium,	2·166399	16·637945
Bromid of magnesium,	0·115014	0·873307
Iodid of calcium,	0·080397	0·617448
Carbonate of baryta,	0·003784	0·029062
" strontia,	0·059276	0·455239
" lime,	2·763699	21·225208
" magnesia,	1·376540	10·571828
" iron,	0·038419	0·295057
" manganese,	*traces.*	*traces.*
Silicate of alumina,	0·040830	0·313575
Free silicic acid,	0·102440	0·786739
	48·452088	372·112036
Carbonic acid, loosely bound,	1·952889	14·998187
" " really free,	0·007887	0·060572
	50·412864	387·170795

5. *If the carbonates are accounted as bicarbonates, as they are contained in the salt water, then the proportions will be as follows:*

	In 1000 parts.	In one pound = 7680 grains, are grains:
Chlorid of sodium,	32·977783	253·269374
" potassium,	0·040702	0·312592
" ammonium,	0·006709	0·051525
" barium,	0·006121	0·047009
" strontium,	0·095876	0·736227
" calcium,	8·578099	65·879800
" magnesium,	2·166399	16·637945
Bromid of magnesium,	0·115014	0·873307
Iodid of calcium,	0·080397	0·617448
Bicarbonate of baryta,	0·004632	0·035574
" strontia,	0·077015	0·591475
" lime,	3·971630	30·502119
" magnesia,	2·088071	16·036385
" iron,	0·053259	0·409029
" manganese,	*traces.*	*traces.*
Silicate of alumina,	0·040830	0·313575
Free silicic acid,	0·102440	0·786739
	50·404977	387·110223
Carbonic acid, really free,	0·007887	0·060572
	50·412864	387·170795

6. 1000 *parts of salt water gave* 48·5 *parts of solid matters. But at* 4 *sub B. there are counted by the analysis only* 48·452088 ; *which is a loss of* 0·047912, *and it is possible, that, when the solid matters were weighed, they had not been perfectly dried. But by distributing this loss upon the single combinations, then we will have the following proportions :*

	In 1000 parts.	In one pound = 7680 grains, are grains :
Chlorid of sodium,	33·010394	253·519827
" potassium,	0·040748	0·312945
" ammonium,	0·006715	0·051571
" barium,	0·006127	0·047055
" strontium,	0·095970	0·736949
" calcium,	8·586581	65·944942
" magnesium,	2·168541	16·654496
Bromid of magnesium,	0·115127	0·884175
Iodid of calcium,	0·080476	0·618055
Carbonate of baryta,	0·003787	0·029084
" strontia,	0·059334	0·455685
" lime,	2·766431	21·246190
" magnesia,	1·377901	10·582281
" iron,	0·038457	0·295349
" manganese,	*traces.*	*traces.*
Silicate of alumina,	0·040870	0·313881
Free silicic acid,	0·102541	0·787515
Solid matters,	48·500000	372·480000
Carbonic acid, loosely bound, as bicarbonate,	1·952889	14·998187
" " really free,	0·007887	0·060572
	50·460776	387·538759

The large quantity of compounds of bromine and iodine contained in the brines of the Alleghany and Keskeminetas valleys, which are greater than in any other saltwater hitherto subjected to analysis, of which the results are known, together with their other constituents, recommend them strongly for use as baths in various diseases of the skin, in rheumatic-arthritic diseases, in certain pains of the abdominal and nervous system, in amenorrhœa and menstruatio suppressa, as a preparatory course to the use of iron baths. They have been found particularly useful in glandular diseases, and various forms of scrofula.

For therapeutic purposes baths of the crude brine may be used with advantage, as well as the mother-lye; the latter of course contains the combination of bromine and iodine in a much more concentrated form, and when used should be diluted as may be required by the addition of brine or fresh water.

I would pointedly call the attention of the medical profession to the powerful medical effect of these saltwaters, the more so, as within my own experience persons afflicted with the most inveterate scrofulous affections have been radically cured by using baths of the brine and mother-lye under my direction.

In conclusion I may remark that the inflammable gas alluded to consists essentially of 'marsh gas' (C_2H_4), with some carbonic acid and traces of oxygen and nitrogen.

No olefiant gas (C_4H_4) could be detected.

Tarentum, Alleghany county, Penn., March, 1862.

ART. VI.—*A Sketch of the Mandan Indians, with some Observations illustrating the Grammatical Structure of their Language;* by Dr. F. V. HAYDEN.*

THE Indians of the Missouri valley are divided into the nomadic and stationary tribes. The first class includes by far the greater number, who live mostly by the results of the chase, occupying skin tents and moving about from place to place, as their caprice or physical wants may dictate. Of the latter class, the Minnetarees, Arickaras, and Mandans are the best examples.

The Minnetarees or Gros Ventrees, as they are called by the Canadian Voyageurs, reside in a village of dirt lodges, near Fort Berthold, in lat. 47° 30′, lon. 102°. The village is surrounded by a rude stockade formed of cotton-wood logs, about fifteen feet in height, placed in the earth in an upright position. These Indians raise corn, beans, pumpkins, &c., to a considerable extent, even more than they need for their own support. They now number from 600 to 800 souls, but are decreasing slowly from disease and other causes.

The Arickaras or Rees occupy a village near Fort Clarke, lat. 47° 10′, lon. 101°, very similar to that of the Minnetarees. They also cultivate the bottom lands along the Missouri quite successfully, and in this way add largely to their means of comfort and support. The number of people comprising this tribe at the present time is about 650, men, women and children.

The Mandans or Mi-akh-ta-nīs, "people on the bank" (of the river), as they call themselves, must have resided on the banks of the Missouri at a very remote period, perhaps not near their present residence, but in several places along the river. It is also probable that if they migrated at all, they came from a southern direction, as the sites of different villages of very ancient date are seen along the Missouri, as low down as the present boundary between the United States and the Dakota country. Some of these antique ruins are said to have been Arickara vil-

* This Sketch is taken in part from a Memoir by the author entitled "Contributions to the Ethnography and Philology of the Indian Tribes of the Missouri Valley," now in course of publication by the American Philosophical Society, Philadelphia.

lages, which is doubtless the case. The observations thus far made, point to the conclusion that all these stationary tribes migrated in the same direction, from southeast to northwest along this river, which may be inferred from the circumstance that no remains of their villages are to be seen along any other stream than the Missouri.

Prior to the visit of Lewis and Clarke in the autumn of 1804, we possessed very little information of a reliable character in regard to the origin and early history of the Mandans. Col. D. D. Mitchell, in a letter addressed to Mr. H. R. Schoolcraft, and published in the 3d part of the "History of the Indian Tribes," refers to an early writer by the name of Macintosh, who it seems was connected with a French Trading Company as early as 1772. From his own account he left Montreal in the summer of 1773, crossing over the intervening country, reached the Mandan Villages on Christmas day. He says that at that time the Mandans occupied nine large towns, situated very near each other, and that at short notice they could muster 15,000 warriors. This is doubtless a great exaggeration, but that they were a formidable nation the ruins of numerous villages, along both sides of the Missouri, bear ample testimony.

The following extracts from the well-known work, "Travels of Lewis and Clarke to the Source of the Missouri," show very clearly the condition of the Mandans and other stationary tribes in 1804.

"The villages near which we are established are five in number, and are the residence of three distinct nations; the Mandans, the Ahnahaways, and the Minnetarees. The history of the Mandans, as we received it from our interpreters and from the chiefs themselves, and as it is attested by existing monuments, illustrates, more than that of any other nation, the unsteady movements and the tottering fortunes of the American nations. Within the recollection of living witnesses, the Mandans were settled forty years ago in nine villages, the ruins of which we passed about eighty miles below, and situated seven on the west and two on the east side of the Missouri. The two finding themselves wasting away before the small pox and the Sioux, united into one village, and moved up the river opposite to the Ricaras. The same causes reduced the remaining seven to five villages, till at length they emigrated in a body to the Ricara nation, where they formed themselves into two villages, and joined those of their countrymen who had gone before them. In their new residence they were still insecure, and at length the three villages ascended the Missouri to their present position. The two who had emigrated together still settled in the two villages on the northwest side of the Missouri, while the single village took a position on the southeast side. In this situation they were found by those who visited them in 1796; since which the two villages have united into one. They are now in two villages, one on the southeast of the Missouri, the other on the opposite side, and at the distance of three miles across. The first, in an open plain, contains about forty or fifty lodges, built in the same way as those of the Ricaras; the second, the same number, and both may raise about three hundred and fifty men.

"On the same side of the river, and at the distance of four miles from the lower Mandan village, is another called Mahaha. It is situated on a high plain at the mouth of Knife-river, and is the residence of the Ahnahaways. This nation, whose name indicates that they were "people whose village is on a hill," formerly resided on the Missouri, about thirty miles below where they now live. The Assiniboins and Sioux forced them to a spot five miles higher, where the greatest part of them were put to death, and the rest emigrated to their present situation, in order to obtain an asylum near the Minnetarees. They are called by the French Soulier Noir, or Shoe Indians; by the Mandans, Wattasoons, and their whole force is about fifty men.

"On the south side of the same Knife-river, half a mile above the Mahaha, and in the same open plain with it, is a village of Minnetarees, surnamed Metahartay, who are about one hundred and fifty men in number. On the opposite side of Knife-river, and one and a half miles above this village, is a second of Minnetarees, who may be considered as the proper Minnetaree nation. It is situated in a beautiful low plain, and contains four hundred and fifty warriors. * * * * * *

"The inhabitants of these five villages, all of which are within the distance of six miles, live in harmony with each other. The Ahnahaways understand in part the language of the Minnetarees; the dialect of the Mandans differs widely from both; but their long residence together has insensibly blended their manners, and occasioned some approximation in language, particularly as to objects of daily occurrence and obvious to the senses."

At the present time the Mandans occupy a small village about three miles above Fort Clarke, on the right bank of the Missouri, and do not number over 250 or 300 souls. The Ahnahaways mentioned by Lewis and Clarke were undoubtedly a portion of the Mandan nation, but I cannot discover any trace of their existence at this time. In 1833, when the Prince Neu Wied made his visit to the Upper Missouri, he remarks that the two Mandan villages were located the one about 300 paces above Fort Clarke, and the other about three miles higher up, on the same side of the river. It is evident that the former is now occupied by the Arickaras, while the latter is in possession of the small remnant of the Mandan nation now living. At the period above mentioned (1833) the first village was composed of 65 huts, with about 150 warriors, and the latter 38 huts with 83 warriors, both villages perhaps possessing 900 to 1000 souls.

Our knowledge of this nation obtained from the American Fur Company, commences in the year 1829, when, through that company, the Fur-trade on the Upper Missouri was established on a more solid basis than it had been by the French traders. Anterior to the above date, the latter had been trading with these Indians in their usual way, by building wintering houses, putting therein a trader and a few men, with a small supply of goods, and abandoning the post in the spring, taking with them down the river their returns of furs and skins. The Arickaras at this time were residing in their village near Grand river, the ruins of which are still visible. In 1829 Fort Clarke was erected for the express purpose of trading with the Mandans and Minnetarees. The former tribe then possessed a population of about 1800 persons, and the latter about half that number.

It is somewhat remarkable that notwithstanding all the misfortunes that have overtaken the Mandans for so many years, they even to this time preserve their independence and individuality as a nation. Nearly all the Mandans speak the Minnitaree language, and many of them are familiar with the Dakota and Arickara tongues, but very few, if any, of the surrounding tribes have acquired that of the Mandans. But one white man has ever learned to speak the language fluently and he resided among them upwards of twenty years. I cannot ascertain that there are any peculiar difficulties in the pronunciation or structure of the language which should prevent individuals of other nations from acquiring it readily; indeed I think that the evidence is quite clear, as suggested by Mr. Gallatin, that it is remotely allied to the Dakota stock and presents few, if any more obstacles to its acquisition than the other dialects of that group.

In the year 1833 the Mandans were in their most prosperous state, well armed, good hunters, good warriors, with herds of buffalo within sight of their village—large cornfields and a trading post from which they could at all times obtain needed supplies. In their personal appearance prior to the ravages of small-pox, they were not surpassed by any nation in the Northwest. The men were tall and well made, with regular features and a mild expression of countenance not usually seen among Indians. Their complexion also was a shade lighter than that of other tribes, often approaching very near to that of some European nations. Another peculiarity, which has often been observed by travellers, was that some of them had fair hair, and gray or blue eyes, which are very rarely met with among other tribes. A majority of the women, particularly the young, were quite handsome, with fair complexions and modest in their deportment. They were also noted for their virtue. This was regarded as an honorable and most valuable quality amongst the young women, and each year a ceremony was performed in the presence of the whole village, at which time all females who had preserved their virginity, came forward, struck a post, and challenged the world to say ought derogatory of their character. As this was a religious ceremony, any persons present, who could with truth contradict the statement, felt bound to do so, and if detected in a false statement, the female lost her standing forever afterward among the young of both sexes. In ordeals of this kind it was remarked that more than two thirds of the Mandan females came off victorious which is regarded as a great proportion, when the early training and the influences that surround them are taken into consideration. The fact that a ceremony of this kind exists among savages, tending to promote virtue and discourage vice, is, of itself, sufficient evidence of their mental as well as moral superiority.

Much more might be said in regard to the habits and characteristics of this tribe, which is one of the most interesting in the West, but we prefer to occupy the space allotted in some illustrations of the grammatical structure of their language. At this time the Mandans cultivate the soil and hunt buffalo when these animals are near their homes. The destructive influences of the small-pox which has, at different times, raged fearfully among them, have never crushed their indomitable spirit of pride and independence. They will not join with other nations near whom they reside, neither will they connect themselves with them by marriage, nor allow or practice any customs but those of their ancestors. Their religious rites are preserved entire, and the system of self-inflicting tortures is practiced at the present day. Being too few in number to form war-parties against neighboring tribes, they remain at home and defend themselves. The Dakotas frequently attack them, at or near their village, and in almost every engagement some Mandans are killed. In these skirmishes they exhibit an entire recklessness and contempt of death, which leads to acts of individual daring, generally fatal, though feared and respected by the surrounding tribes. Owing to this fact and the periodical visitation of some contagious disease, they are on the decrease, and will doubtless before many years become extinct, or fall a prey to some superior force of Dakotas at an unguarded moment.

Their principal chiefs are now dead, but in former times they held a most beneficent sway over this tribe. Their rule was seldom interrupted by claims or pretensions of other aspirants to public notice. They were respected for their judgment, and loved for the patriarchal care they felt in the general welfare, not feared on account of their personal bravery or extensive relationship as is the case with migratory bands. Old age also in both sexes was held in veneration, made comfortable and not neglected, as is the case with many of the savage tribes. They deposit their dead on scaffolds near their village and in warm weather their decomposition has a tendency to render the atmosphere unhealthy and engender disease, but no persuasion can induce them to bury in the ground according to the custom of the whites.

From the above brief sketch of the Mandans, the inference is plain, that, although they possess all the characteristics of the North American Indians, they present a somewhat peculiar and superior type of the race. The notion that at one time prevailed, that they were of Welch origin, has long since been exploded and it is hardly necessary to allude to it in this connection. Although remotely connected, we think there is sufficient ground for the inference that the Mandan language is a dialect of the Dakota stock. This was the opinion of Mr. Gallatin although he was unable to make the proper comparisons. These I shall endeavor to make in detail at some future time. In the summer of 1855 I made a few observations in regard to the grammatical structure of this language, an abstract of which may be of some interest to those who are curious in such matters.*

I. Nouns.

1. With few exceptions, Mandan nouns have both a singular and plural form, as is shown by their termination: as, a-pe, *a leaf*, a-pīsh, *leaves*; ma-he, *a weed*, ma-hōsh, *weeds*; si, *a feather*, si-īsh, *feathers*.

2. The gender of nouns is indicated by the use of different words to express the sex: as, nu-mán-ke, *a man*; mi-he, *a woman*; hé-ro-ke, *a bull*, ptīn-de, *a cow*, ní-ka, *a calf*.

3. The case of a noun is known by its position in a sentence.

II. Adjectives.

4. Adjectives always follow the nouns which they describe: as, mi-he-shi-na-shūsh, *a handsome woman*; nat-kaṇ-ka-sīsh, *a hard heart*.

5. The numeral adjectives of the cardinal kind are as follows:

1, máh-a-na.	13, a-ga-ná-me-ni.
2, nū′m-pa.	14, a-ga-tō′p.
3, ná-me-ni.	15, a-ga-hū′ṇ.
4, tó-pe.	16, a-ki-ma.
5, kéh-ūṇ.	17, a-kú-pa.
6, ki-ma.	18, ak-tí-tuk-e.
7, ku-pa.	19, a-ga-máh-pe.
8, té-tuk-e.	20, nū′m-pa-pí-rah.
9, mah-pe.	21, nū′m-pa-pi-ra-ka-ro-máh-a-na.
10, pi-rah.	30, ná-me-ni-am-pí-ra-kōsh.
11, a-ga-máh-a-na.	40, tó-pa-pí-ra-kōsh.
12, a-ga-nū′m-pa.	50, keh-ūṇ-am-pí-ra-kōsh.

* In the "Contributions" a plan of orthography has been adopted, corresponding as closely as possible with the one prepared by the late Prof. W. W. Turner for the Smithsonian Institution.

All the vowels have the continental sound, as *a* in father, *e* in face, *i* in marine, *o* in go, note, *u* like *oo* in food. When a vowel terminates a syllable it is long, but if a consonant is added, the vowel is short. Exceptions to this remark are indicated as follows: *ŏ* as in got, or *ō* long, as in note when followed by a consonant. *G* has always the hard sound as in go, *h* when preceded by a vowel has the guttural sound of *ch* in the Scottish loch or Arabic ghain, *n* is sounded as in the French word *bon*. The above remarks are all that are needed for the pronunciation of the Mandan language.

60, kí-ma-am-pí-ra-kōsh.
70, kú-pa-am-pí-ra-kōsh.
80, te-tuk-e-am-pí-ra-kōsh.
90, máh-pe-am-pí-ra-kōsh.
100, i-sū'k-máh-a-na.
1000, i-sú-ki-ka-kú-hi.
100,000, i-sú-ki-ka-kú-hi-i-sū'h-máh-a-na.
ná-ka-máh-a-na, *first one*, or *first time*.
i-ká-ha-sha-máh-a-na, *last one*, or *last time*.

III. Adverbs.

6. The following are some of the principal adverbs: tash-hák-tōsh, *perhaps;* hó-ra-ke-ku-sér-o, *day before yesterday;* mat-khé-o-más to, *day after to-morrow;* tēn-hásh, *afar off*.

IV. Prepositions.

7. Prepositions follow the nouns they govern: as, péh-ti, *by*, mi-péh-ti-nák-ta, *sit by me;* mun-i-kū'sh-ta, *through the water;* ti-rō'k-ta, *in the house*.

V. Conjunctions.

8. kén-i and ek-tē'k, *and;* kén-i-é-pīsh, *and I said;* kén-i-wa-ki-wá-wa-rūsh, *and I told him*.

VII. Pronouns.

9. Pronouns are simple or fragmentary. The fragmentary pronouns are used in the declension of nouns and adjectives and in the conjugation of verbs. The following may be regarded as an example of the intensive form of the simple pronoun.

mí-o-na, *I, myself*, or *I am*.
ní-o-na, *thou, thyself*, &c.
i-o-na, *he, himself*, &c.
nú-o-na, *we, ourselves*, &c.
ni-á-o-na, *you, yourselves*, &c.
i-á-o-na, *they, themselves*, &c.

The form of the fragmentary pronouns is shown in the following declensions of nouns and adjectives.

mi-hū'n-de, *my mother*.
ni-hū'nde, *thy mother*.
i-hū'n-de, *his mother*.

mōṇs, *my wife*.
nōṇs, *thy wife*.
kōṇs, *his wife*.
mōṇ-kér-ish, *my wives*.
nōṇ-kér-ish, *thy wives*.
kōṇ-kér-ish, *his wives*.

mín-i-ke, *my son*.
nín-i-ke, *thy son*.
i-kó-ni-ke, *his son*.
min-i-kōsh, *my sons*.
nin-i-kōsh, *thy sons*.
i-ko-ni-kōsh, *his sons*.

ma-shīsh, *I am good*.
ni-shīsh, *thou art good*.
iṇ-shīsh, *he is good*.
nu-shīsh, *we are good*.
ni-a-shīsh, *you are good*.
i-a-shīsh, *they are good*.

Verbs.

The following examples show the changes in the form of the verbs.

i-wa-seh-osh, *I do* or *perform anything*.
i-da-seh-osh, *thou*, &c.
i-i-seh-osh, *he*, &c.
nu-i-seh-ōsh, *we*, &c.
ni-i-seh-ōsh, *you*, &c.
i-a-i-seh-ōsh, *they*, &c.
nu-nōmp-sha-seh-ōsh, *we both do*, &c.
i-wa-seh-tōsh, *I*, &c.
ni-de-seh-tōsh, *thou*, &c.
i-seh-tōsh, *he*, &c.

nu-i-seh-tōsh, *we*, &c.
ni-a-seh-tōsh, *you*, &c.
i-o-na-seh-tōsh, *they*, &c.
wa-wa-ka-pu-sōsh, } *I paint or write*,
wa-ka-pu-sōsh, } or *am painting*.
tha-ka-pu-sōsh, *thou*, &c.
iṇ-ka-pu-sōsh, *he*, &c.
wa-ka-pūs-tōsh, *I will paint* or *write*.
ma-ka-pūs-tōsh, *thou*, &c.
iṇ-ka-pūs-tōsh, *he*, &c.
nu-ka-pūs-tōsh, *we*, &c.
ni-a-tha-ka-pūs-tōsh, *you*, &c.
ni-a-he-seh-ta (imperative), *do it all of you*.
i-sek-ta (imp.), *do*.
nu-ka-pu-sōsh, *we*, &c.
ni-a-pu-sōsh, *you*, &c.
i-a-pu-sōsh, *they*, &c.
nu-nōmp-sha-pu-sōsh, *we both*, &c.
i-a-ka-pūs-tōsh, *they*, &c.
wa-ka-pu-se, *a painting or writing*.
ka-pūs-ta, (imp.) *write*.
a-he-ka-pūs.ta, (imp.) *write, all of you*.

Impersonal Verbs.

kap-kēsh, *it snows*.
kap-ke-kōsh, *it will snow*.
kap-ke-a-maṇ-ka-hōsh, *it is snowing all the while*.
ra-she-de-hūsh, *it thaws or melts*.
ra-she-dēh-tūsh, *it will thaw or melt*.
ktaṇ-hōsh, *it freezes*.
ktan-tōsh, *it will freeze*.
ra-pa-na-rūsh, *it hails*.
ra-pa-nak-tūsh, *it will hail*.
he-i-ni-hūsh, *it thunders*.

The most reliable account of the manners and customs of the Mandans which has ever been published may be found in a magnificently illustrated work entitled "Reise des Priusen Maximilian zu Wied. 2 vols. 4to." The Prince of Neu Wied resided one winter with this tribe, and obtained his information under the most favorable circumstances, and therefore I regard it as entitled to great confidence. In the same work may be found an extended vocabulary—the only one ever published of this language, of any great value for philological purposes—with some interesting grammatical observations. The great flexibility of the Indian languages, and the extent to which combinations may be made, have induced some authors to complicate greatly the declension of the nouns and adjectives and the conjugation of the verbs. Sometimes the moods and tenses of verbs are multiplied to an almost indefinite extent, and the six cases of the Latin given to the substantives. I do not dispute the accuracy of any author on this subject; but simply say that I have not yet been able to find a grammatical system so complete in any of the Indian languages of the Northwest. So far as I can ascertain there are three moods to the verbs, indicative, imperative, and infinitive; three tenses, past, present, and future; and I cannot find that the simple form of the verb expresses more. Other tenses are formed by the union of different words. More thorough investigations hereafter will decide this matter.

The following examples are taken from the Prince Neu Wied's great work, in which he has treated of a number of the Indian languages of the Northwest. The orthography is slightly changed to adapt it to the system which I have adopted in my Memoir. To one unacquainted with the native languages of this country, it would seem hardly possible to find a grammatical structure so complicated and still so complete and systematic, yet perhaps there is no cultivated tongue among the civilized nations of the world more regular than that of the Chippewa and its cognate dialects. In the Dakota there are three numbers, singular, dual, and plural. In the Eskimo, according to Bäer, nouns have six cases, the same as Latin nouns, and three numbers, through all of which they are inflected. In the Yakama, one of the numerous dialects on the Pacific coast, as given by Father Pandosy, nouns and adjectives possess the six cases mentioned above, but only two numbers, the singular and plural, and the verb is conjugated with greater minuteness of detail. We can thus see that a careful study of our own aboriginal languages becomes a subject of the highest interest and importance to every professed philologist.

Declensions of Nouns.

Sing.	*Sing.*
nú-maṇ-ka, *the man.*	wo-ra-e-rú-pa, *the bow.*
nu maṇk-á-da, *of the man.*	wo-ra-e-rú-pa-da, *of the bow.*
O-nu-maṇk, *to the man.*	wo-ra-e-rú-pa-á-ta, *to the bow.*
nú-maṇ-ka, *the man.*	wo-ra-e-rú pa, *the bow.*
nu-máṇk, *O man.*	wo-ra-e-rú-pa, *O the bow.*
nú-maṇ ka, *with the man.*	wo-ra-e-rú-pa-ta, *with the bow.*
Plur.	*Plur.*
nu-maṇ-ká-ra, *the men.*	wo-ra-e rú-pa-ke-rēsh, *the bows.*
O-nu-maṇ-ka, *of the men.*	wo-ra-e-rú-pa-ka-ra-tá, *of the bows.*
nu-maṇ-ka-ra-ta, *to the men.*	we-pa-e-rú-pa-ka-ra-a-tá, *to the bows.*
nu-maṇ-ka-ra, *the men.*	O-wo-ra-e-rú-pa-ke-rē'sh, *the bows.*
nu-man-ká-ke, *O the men.*	wo-ra-e-rú-pa-ke-rē'sh, *O the bows.*
wanting.	wo-ra-e-rú-pa-ka-ra-tá, *with the bows.*

Remarks in regard to Adjectives.

The adjective follows the noun which it qualifies or describes: as, minī's-, shó-ta, *the white horse*, or *horse-white*, nu-mamk-, há-ra-ka, *the bold man*, pa-san-, psīsh, *swift-river.*

The comparative degree of adjectives is formed by the addition of the word o-páh-a-dēsh, "more," and the superlative by the addition of the word mí-kāsh, "most," as, shīsh, *good*, shi-, o pah-a-dēsh, *better*, shī-, mikāsh, *best;* kā'sh-ka, *great*, násh-ka-, o-pah-a-dēsh, *greater*, kásh-ka-, mikash, *greatest.* ath-, hā'sh-kāsh, *this is great.* ath-, shīsh, *this is good.*

The verbs also are conjugated with remarkable regularity. A few forms only are given: wa-wa-ru-tōsh, *I eat* or *am eating;* wa-ra-ru-tōsh, *thou eatest* or *art eating;* i-wa-ru-tōsh, *he eats* or *is eating;* wa-nu-rutōsh, *we eat* or *are eating;* i-wa-ru-toh-e-dēsh, *you eat* or *are eating;* rowa-ru-ta-maṇ-ka-hūsh, *they eat* or *are eating;* wa-wa-rūt-ma-kih-hāsh, *I have eaten;* wa-wa-rūk-tōsh, *I shall* or *will eat;* i-u-a-ha-ra-pōsh, *I would have eaten;* wa-rūs-tá, *eat* (imperative); wá-ru-te-nis-tá, *eaten;* wa-rú-tamáṇ-ka-hūsh, *eating.*

The preceding examples, of which many more might be given, will serve to convey to the reader an idea of the strength and fulness of our aboriginal languages. Many of them seem to possess even greater flexibility than those of the cultivated nations of Europe. My own experience is confirmed by that of one of the most intelligent missionaries of the West, Rev. Wm. Hamilton, who has spent the greater portion of his life among the Iowas, and speaks their language with great fluency. In the preface to his excellent and elaborate grammar of the Iowa tongue he remarks that "the barrenness which is supposed to belong to most Indian languages, does not result from the structure or nature of the language, but from the want of ideas in those who use it. So far as *they have ideas*, they do not lack *words* to express them, though the mode of expression, among them, is often as different from that in use among us, as their language is from ours."

Smithsonian Institution, Washington, D. C., May 20th, 1862.

ART. VII.—*On Triethylamine;* by M. CAREY LEA, Philadelphia.

THE triethylamine which served for the following examinations was obtained, by the action of nitrate of ethyl upon ammonia, making the alkaloids thus obtained react upon fresh portions of the compound ether. The following was the course of the operation.

Three volumes of nitrate of ethyl with three volumes of liquid ammonia, thoroughly saturated with ammoniacal gas and two volumes of absolute or nearly absolute alcohol, were sealed up in glass tubes and were kept in boiling water for four hours. The tubes were then opened, the contents neutralized with nitric acid, and evaporated over a chlorid of calcium bath. When freed as far as possible from water, the pasty mass was placed in a flask, with four volumes of absolute or nearly absolute alcohol and a sufficient quantity of caustic soda in powder. Heat was applied and the vapors disengaged were conducted into three volumes of nitrate of ethyl mixed with two of absolute alcohol, kept cool by a freezing mixture. At the close of the operation it was necessary to add a little water to the contents of the flask in order to complete the decomposition. The absorption of the distillate was complete, and the liquid thus saturated was again enclosed in sealed tubes and heated. The entire number of charges was forty-two, of which five were lost by explosion. For the convenience of those who may use this method of obtaining the ethyl bases, I give the results which I observed as to the strength of tube necessary:

Tubes of one inch external diameter, weighing
5 ounces to the foot generally burst.
6 to 7 " " generally resisted, but not always.
8 to 10 " " were found safe.

This refers to tubes charged from three-sevenths to one-half. Beyond this charge, greatly increased strength becomes necessary.*

The disposition to burst appeared to be greater in the second heating than in the first. It is therefore better to heat for 11 or 12 hours to 180°–190° F. rather than risk the loss of products which have already cost considerable time and trouble.

In describing the properties of ethylamine and diethylamine, I have shown that when nitrate of ethyl is made to react upon ammonia, the resulting alkaloids are easily separated from each other by means of picric acid. It is a familiar fact that when several salts are present in one solution, the facility of separating them by crystallization will often depend upon the relative proportion in which they are present, and this holds good in the present case. When ammonia acts upon nitrate of ethyl, and the bases, after separating the ammonia, are converted into picrates, we have a mixture of the salts of ethylamine and diethylamine in nearly equal quantities, with a variable quantity of triethylamine, always very small and sometimes a mere trace, always separating out in the first crystallization. But when nitrate of ethyl is made to react again upon the products of the first reaction, the proportions of the alkaloids are very different. Diethylamine then constitutes about three-fourths of the whole, and the residue is chiefly triethylamine mixed with some ethylamine. When these bases are converted into picrates the diethylamine salt still separates with great facility, sinking to the bottom at a certain stage of concentration as a heavy oily fluid.† Previously to this,

* It has been very generally recommended in text books to wrap pressure tubes in cloths to prevent the explosion of one from destroying the rest. When this is done, the extremities of the tube should always be left clear. It is at the extremity that the explosion almost always takes place, and if there is not an easy escape for the expanding vapors, so great a disturbance follows that much damage may be done. In this way I have seen every tube in a boiler broken by the explosion of one, whereas, since I have adopted the plan of leaving the ends perfectly free, when an accident has taken place I have always escaped with the loss of the one.

† The latter portions of this oily fluid which separate are often pasty with the needles of the less soluble compounds, from which they are best separated by ether in which picrate of diethylamine is extremely, and the other picrates very sparingly soluble. As a proof how exactly diethylamine may be separated from its cognate bases by conversion into picrates, I subjoin analyses made at various times, some of which have been published before, others not:

(1.)	·7144 gramms chloroplatinate gave Pt,		·2552
(2.)	·9961 "	"	·3549
(3.)	·3884 "	"	·1377
(4.)	1·9129 "	"	·6764

These correspond to

(1.) Per cent platinum, - - - -	35·72
(2.) " " - - - - -	35·63
(3.) " " - - - - -	35·45
(4.) " " - - - - -	35·36
Theory requires (Pt=98·7) - - -	35·35
" " (Pt=99) - - -	35·45

the picrates of ethylamine and triethylamine crystallize out in yellow needles. The separation of these last from each other by crystallization when the triethylamine is present in considerable proportion, cannot be as satisfactorily effected, as when it is present in small quantity only. It therefore became necessary to seek for a good mode of effecting this separation.

Triethylamine is but moderately soluble in water, and when the water present is insufficient to dissolve it, it forms a layer on the surface. It seemed possible that its affinity for ether might be greater than for water, and experiment proved this to be the case. When ether is agitated with aqueous solution of ammonia, ethylamine, or diethylamine, it takes up but little of the base, but when agitated with aqueous solution of triethylamine, it becomes strongly charged. A portion of ether agitated with a mixture of the aqueous solutions of ethylamine and triethylamine and then treated with hydrochloric acid and bichlorid of platinum and spontaneously evaporated, gave only crystals of triethylamine salt, which is easily distinguished from the platinum salt of ethylamine: no traces of the presence of the latter were observable. It therefore seemed worth while to test the process by a careful series of analyses, which was done with the following results.

The moderately strong aqueous solution of the mixed bases, triethylamine and ethylamine, was agitated several times with about $\frac{1}{10}$ its bulk of ether and left some time to separate thoroughly, after which the ether was removed by a separating funnel. This was repeated three or four times. It was evident that if these ethereal solutions of triethylamine thus obtained were contaminated with ethylamine, the latter substance would be present in largest proportion in the latter portions of the ether. In order therefore to render the test more rigorous, these latter were examined in preference, and with the following results.

Portions of the etherial solution were treated with excess of hydrochloric acid and converted into platinum salt with excess of bichlorid of platinum.

(1.)	·7031 gms. substance gave metallic platinum,	·2264
(2.)	1·2084. " " "	·3873
These correspond to		
(1.)	per cent platinum, - - - - -	32·20
(2.)	" " - - - - -	32·06
	Mean of two analyses, - - -	32·13
	Theory requires (Pt=98·7)* - -	32·13

An eminently satisfactory result.

In order to ascertain if the whole of the triethylamine were removed by this proceeding, the aqueous solution, after four washings with ether, was submitted to analysis. Its chloroplatinate gave by ignition

* I have taken this number for Pt as that adopted by the last numbers of the Jahresbericht.

·6373 substance, platinum, - - - - -	·2487
Corresponding to, per cent platinum, -	39·02
Theory requires, - - - - - -	39·29

The number found falls a little below the theoretical proportion, and may indicate that a trace of triethylamine remained in the aqueous solution. I may however remark that this slight discrepancy is within the error of a careful analysis, particularly with substances whose analysis requires so much circumspection as these. Two analyses of chloroplatinate of ethylamine of which the alkaloid had been separated by picric acid gave respectively 39·02 and 39·23, the first of which numbers is identical with that above found.

Ether appears therefore to afford a convenient mode of separating ethylamine and triethylamine, after diethylamine has been eliminated by means of picric acid. This is a necessary condition: when observed, the process gives, so far as my experiments go, good results.

Properties of Triethylamine.

Triethylamine is an oily fluid lighter than water, and floating on its surface when the water present is insufficient in quantity to hold it in solution. When therefore the crystallized hydrochlorate is added to a concentrated solution of caustic soda, the triethylamine separates and rises to the surface. It has an agreeable ammoniacal odor, which appeared to me to be pleasanter and more aromatic than those of ethylamine and diethylamine. This however is a matter on which it is difficult to speak positively, as the odor of ammonias appears to be influenced by adventitious circumstances. Stas found the oder of perfectly pure ammonia prepared by him, to be quite different from that ordinarily recognized as characteristic of the substance.

It is not very soluble in water, but emulsifies very easily with it. When a stratum of triethylamine is resting upon the surface of a saturated aqueous solution, a very slight agitation is sufficient to produce a complete emulsion, and a considerable time elapses before the stratum separates again. It is capable of acting under some circumstances as a reducing agent, separating gold in the metallic state with production of aldehyd, as will be described further on, but unites with chromic acid without decomposition.

Reactions of Triethylamine with solutions of metallic bases.

The following reactions were obtained with a saturated aqueous solution of pure triethylamine:

Zirconium, sulphate of Zirconia,	**White precipitate, insoluble in excess of precipitant.**
Aluminium, tersulphate alumina,	**White precipitate, dissolving readily and completely in excess of the precipitant.**

Glucinum, sulphate of glucina,	White precipitate, insoluble in excess of precipitant.
Cadmium, sulphate,	White precipitate, insoluble in excess of precipitant.
Zinc, sulphate,	Same reaction.
Nickel, chlorid,	Green precipitate, insoluble in excess of precipitant.
Cobalt, protochlorid,	Greenish blue precipitate, insoluble in excess of precipitant.
Lead, neut. acetate,	The white precipitate dissolves in excess of lead solution, but is insoluble in any excess of triethylamine.
Tin, protochlorid,	White precipitate, insoluble in excess of precipitant.
" bichlorid,	White precipitate, dissolving completely in excess of precipitant.
Silver, nitrate,	Brown precipitate, somewhat soluble in excess of precipitant.
Gold, terchlorid,	Yellow precipitate, insoluble in excess and speedily becoming blackish. The action of triethylamine on gold solution is remarkable and may be considered as the most distinctive characteristic between this and the allied alkaloids. Triethylamine added to terchlorid of gold throws down a yellow precipitate, which in a few moments darkens and soon appears black, but examined in thin layers is found to be dark bluish green. This precipitate treated with hydrochloric acid partly dissolves with formation of terchlorid and leaves a residue of metallic gold in the form of a brown powder. The precipitate at first formed by the alkaloid speedily passes therefore into protoxyd of gold. This reduction is accompanied by the evolution of aldehyd, and is carried even further than the production of protoxyd, part of the gold being reduced to the metallic form. For after standing a few minutes, a bright film of gold collects on the surface of the liquid, and after a few hours the sides of the test glass are found to be covered with a brilliant speculum of metallic gold.
Platinum, protochlorid,	No precipitate.
" bichlorid,	A saturated aqueous solution of triethylamine gives no precipitate with a concentrated solution of bichlorid of platinum.

Palladium, protochlorid,	No precipitate.
Ruthenium, sesquichlorid,	No immediate precipitate. The liquid however soon begins to darken, and a black precipitate falls, which gradually increases until the liquid is decolorized.
Antimony, terchlorid,	Reddish brown precipitate.
Uranium, nitrate,	Abundant yellow crystalline precipitate, insoluble in excess of precipitant.
Mercury, ternitrate,	Yellowish white precipitate, insoluble in excess.
Molybdenum, protochlorid,	Becomes opalescent and by standing deposits a yellowish powder.*
" bichlorid,	Brownish yellow precipitate, insoluble in excess of precipitant.
Chromium, potash chrome alum,	Greyish green precipitate, insoluble in excess of precipitant.
Iron, ferric ammonia alum,	Brown, insoluble in excess.
Copper, sulphate,	Blue precipitate of which not a trace redissolves in excess of the alkaloid. The precipitate after treatment with a large excess of saturated aqueous solution of triethylamine, was filtered and the filtrate tested with sulphydrate of ammonia, which gave not the slightest indication of the presence of copper.
Manganese, protosulphate,	Brownish white, insoluble in excess of precipitant.
Magnesia, sulphate,	White precipitate, insoluble in excess.
Cerium, protochlorid,	White precipitate, insoluble in excess of the precipitant.
" nitrate of protoperoxyd,	Same reaction.

Reactions with Hydrofluosilicic Acids.

Aqueous triethylamine treated with ordinary hydrofluosilicic acid, HFl, $SiFl_2$, gives, when the alkaloid is in excess, a precipitate which readily dissolves in an excess of the acid.

With Knop's hydrofluosilicic acid 2HFl, Si_2Fl_3 no immediate precipitate is formed even when the alkaloid is in excess, but after standing some hours, it becomes a slightly opalescent but almost transparent jelly, so stiff that the test glass may be inverted without spilling it.

Observations on these Reactions—I have already pointed out that the property of redissolving precipitates of alumina, heretofore considered as characteristic of ethylamine, is shared by both diethylamine and methylamine, and expressed the opinion

* Methylamine also precipitates solutions of this salt. My correction of the contrary statement in the last number of this Journal (p. 369) reached the editors when the impression was too far advanced to alter it.

that it might probably be found to extend to the other ethyl and methyl bases. The result above stated affords a confirmation of this view as regards the base now under examination.

The most important points deducible from the above described reactions may be summed up as follows: Towards solution of aluminium, cadmium, nickel, protochlorid of cobalt and bichlorid of tin, the behavior of triethylamine is the same as that of ethylamine and diethylamine, and differs from that of ammonia. With respect to zinc, the behavior of triethylamine resembles that of diethylamine and differs from that of both ammonia and ethylamine. In speaking of the reactions of diethylamine, I pointed out that the oxyds of silver and copper were the only ones redissolved by all three bases, ammonia, ethylamine and diethylamine. We now see that only one, silver, is dissolved by all four, including that here investigated.

Extending the comparison to methylamine and denoting by (W.), reactions observed and recorded by its discoverer, M. Wurtz, with respect to that substance, we find that gold precipitates redissolve in excess of methylamine, but not in excess of triethylamine. Protochlorid of palladium is precipitated by methylamine, and not by triethylamine. Alumina is precipitated and redissolved by both. Zinc, silver, and copper precipitates are redissolved by excess of methylamine (W.) but are insoluble in triethylamine. With respect to cadmium, nickel, and cobalt, the precipitates from solutions of these metals are insoluble in methylamine (W.) and in triethylamine.

Finally we observe that those reactions which may be considered as being eminently characteristic of triethylamine, are those which it exhibits with gold and with copper. These and these only, differ essentially from the reactions of ammonia, ethylamine, diethylamine and methylamine respectively. That with gold solution is especially interesting.

Salts of Triethylamine.

Hydrochlorate.—Crystallizes with great facility in beautiful snow-white feathery laminæ. It is not in the least deliquescent in tolerably dry air;—a portion left exposed for several days in a watch glass did not exhibit the least tendency to liquify. Carefully heated on platinum foil, it disappears without leaving any carbonaceous residue.

The most curious property of this salt is its easy combustibility. A portion of the dry salt readily ignites by contact with a lighted match and burns with a livid green flame.

Sulphate.—Very soluble in water and alcohol. Exposed over lumps of caustic soda, in vacuo, for some weeks, it solidifies to an indistinctly crystalline mass. Heated on platinum foil, it takes fire and burns with a scarcely luminous flame and yellowish scintillations.

Nitrate.—The nitrate of triethylamine appears to be liquid at ordinary temperatures, and is obtained by neutralizing aqueous triethylamine with nitric acid, gently evaporating at a low temperature until the solution is somewhat concentrated, and then placing in vacuo over caustic soda for some weeks. A thick syrupy liquid is thus obtained which does not crystallize. When filtering paper is imbued with this liquid and brought near to a flame, it deflagrates with a sudden flash.

A double sulphate of zinc and triethylamine isomorphous with the double sulphates of Mitscherlich's group does not appear to exist.

Art. VIII.—*Notes on American Fossil Fishes;* by Dr. J. S. Newberry.

In the progress of geological investigation in North America the remains of a large number of fishes have been brought to light, and are now preserved in the various collections, public or private, in different parts of the country. Most of these have been described by Redfield, Gibbes, Jackson, Leidy and myself, but as the descriptions given of them are scattered through a multitude of works, some out of print, and most not readily accessible to the student, I have been frequently requested to publish a *resumé* of what is known of our fossil fishes, with references to the papers in which they are described.

This I now propose, as briefly as possible to do, and for convenience, will divide the subject into several parts, according to the formations in which fossil fishes have been found.

I. Fishes of the Devonian Formation.

Up to the present time no well marked remains of fishes have been discovered in the Silurian rocks of this continent, but, as in the old world, in the Devonian strata they are not unfrequent. By far the largest number of specimens and species have been obtained from the Corniferous limestone of western New York, Ohio, and Indiana. The Portage group in Ohio, and the Catskill in New York and Pennsylvania have also furnished a number of fish remains but of different genera from those of the Corniferous.

The papers which contain descriptions of our Devonian fishes are as follows:

Dr. D. D. Owen and Dr. J. G. Norwood: "Description of a new fossil Fish from the Palæozoic Rocks of Indiana."—Amer. Jour. Science, [2], vol. i, p. 367. 1846.

Prof. Joseph Leidy: "Description of some remains of fishes from the Carboniferous and Devonian Formation of the United States."—Journal Acad. Nat. Sciences Phil., [2], vol. iii, p. 159, 1856.

Prof. Wm. Hopkins, "On a remarkable fossil," &c.—Proc. American Association, 1854, p. 287.

Dr. J. S. Newberry: Fossil Fishes of the Cliff Limestone of Ohio.—Annals of Science, vol. i, 1853.—Proc. Amer. Assoc., 1853, p. 166; Bulletin of the National Institute, 1857, p. 119.

Of these the last contains descriptions of all the species which up to that time had been collected in the Corniferous limestone of Ohio, about a dozen in number, including representatives of three genera supposed to be new. These species are as follows:

Agassichthys Manni, N. (=*Macropetalichthys.*)
" *Sullivanti*, N. "
Machaeracanthus major, N.
" *peracutus*, N.
" *sulcatus*, N.
Onychodus Hopkinsi, N.
" *sigmoides*, N.
Psammodus antiquus, N.
Oracanthus fragilis, N.
" *granulatus*, N.
" *abbreviatus*
" *multiseriatus*

The three genera proposed in this paper, namely, *Agassichthys*, a large cœlacanth ganoid; *Onychodus*, represented by a group of placoid teeth, and *Machaeracanthus*, based on some remarkable unsymmetrical double-edged spines, as they are characteristic of the formations in which they are found, and of considerable zoological interest, seem to require a few words of descriptive comment.

Of these, the first, I am now satisfied includes the ichthyic cranium described by Doctors Owen and Norwood under the generic name of *Macropetalichthys.* The specimen described by these gentlemen was found in the Cliff limestone at Madison, Indiana. When it came into their hands, it was much broken. As a consequence the description based upon it was very imperfect, and in some respects erroneous, and, as will be seen, sure to mislead any one who might discover other representatives of the genus to which it belonged. Dr. Owen described his fish as "being entirely destitute of a tubercled dermal surface; as without distinct eye-orbits; provided with two spinous appendages, or horns, and having the scutcheons covered with angular, irregular, rhomboidal, enamelled, but minute scales," all of which is entirely at variance with the characteristics of the large number of crania which I have examined, derived from the same formation, and which, judging from a plaster cast of the original which I have seen, are generically identical with that described by Dr. Owen.

This fish, which must now be known by the name of *Macropetalichthys*, is not only of interest to the palæontologist and zoologist as the most characteristic vertebrate of the epoch of the Corniferous limestone on this continent—the ganoid monarch of our Devonian seas,—but also as furnishing additional evidence of the parallelism of our lower Devonian strata with the limestones of the Eifel; for a species of this genus, probably identical with one of ours, has been discovered in that formation and locality, and is described and figured by the distinguished palæontologist Hermann von Myer, (Palæontographica, vol. i, p. 102, T. xii).

By von Myer this fish was referred to the genus *Placothorax* of Agassiz, but as I have shown in the paper read before the National Institute, von Myer, misled by the distortion of his specimen, has mistaken the occipital for the nasal extremity of the cranium; and further that it could not be included in *Placothorax*, but must be referred to another genus and another family. The present state of our knowledge of this genus may be comprehended at a glance from the following description and figure.

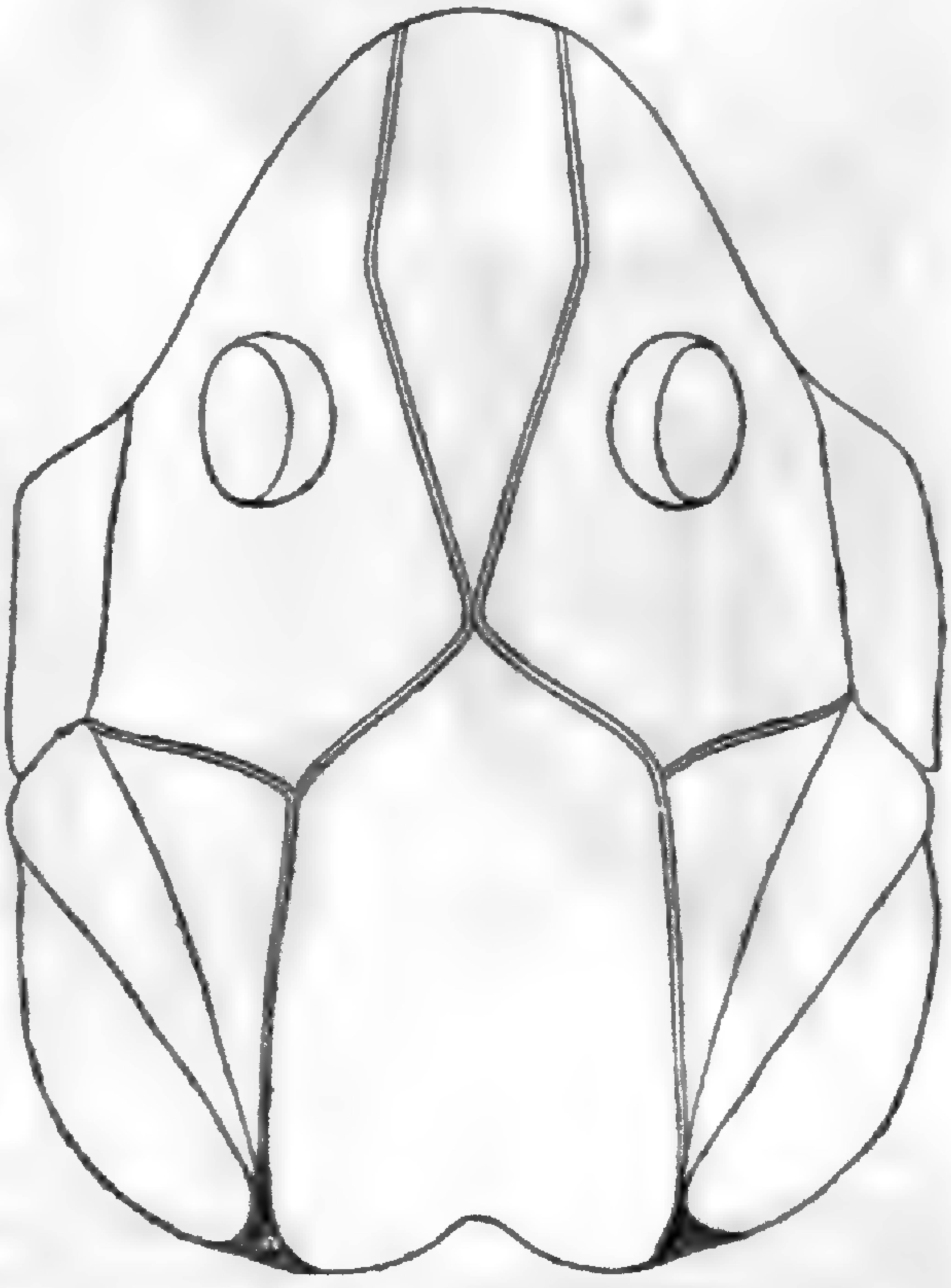
Genus MACROPETALICHTHYS, Owen.

Agassichthys, Newb.

Placothorax, v. Myer, not of Agassiz.

Desc.—Cœlacanth ganoids of large size, cranial surface covered with thickly set stellate tubercles in lines radiating from various centres, or without regular arrangement. Cranium composed of large polygonal plates united by double sutures which are nearly concealed by the tubercled enamel surface. Eye orbits conspicuous and included in the orbital plates. Teeth in two rows, conical, curved, acute, smooth, not plicated at base nor dendritic in structure. Scales obscurely rounded, the exposed portion ornamented with small tubercles and fine divergent raised lines, the covered portion marked with lines of growth, and finely reticulated as in *Rhizodus*, &c.

1.



Cranium of *Macropetalichthys Manni*, N., half natural size.

Of *Macropetalichthys* there are now enumerated four species, viz:

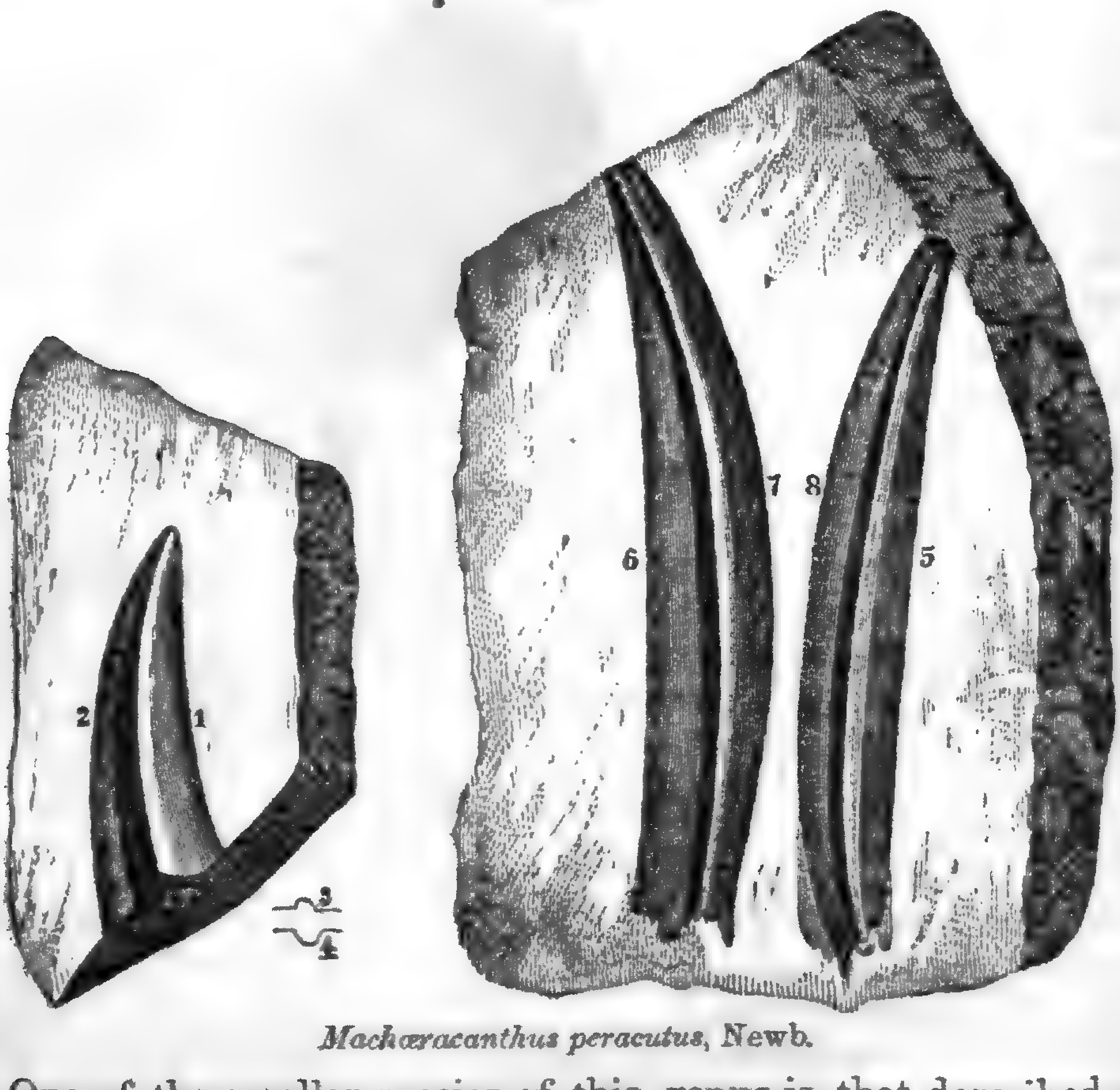
M. Manni, Newb.	*M. Agassizii*, v. Myer, sp.
M. Sullivanti, Newb.	*M. rapheidolabis*, Owen.

It is however possible that the last two are identical with the two former, but just what Owen's species is we shall probably never know, as his description does not tell us and the original specimen has been lost sight of—neither does von Myer's figure and description furnish the means of making an accurate comparison with the American fossils.

Genus Machæracanthus, Newb.

Spines often of large size, flattened, curved, ancipital, unsymmetrical, dextral and sinistral; edges and point generally acute; base somewhat narrowed, with a rough and irregular extremity; central cavity large,—reaching nearly to the apex; external surface covered with a thin coating of enamel, in some species smooth, in others punctate or longitudinally striated; microscopic structure that of dense ivory-like bone.

2.



Machæracanthus peracutus, Newb.

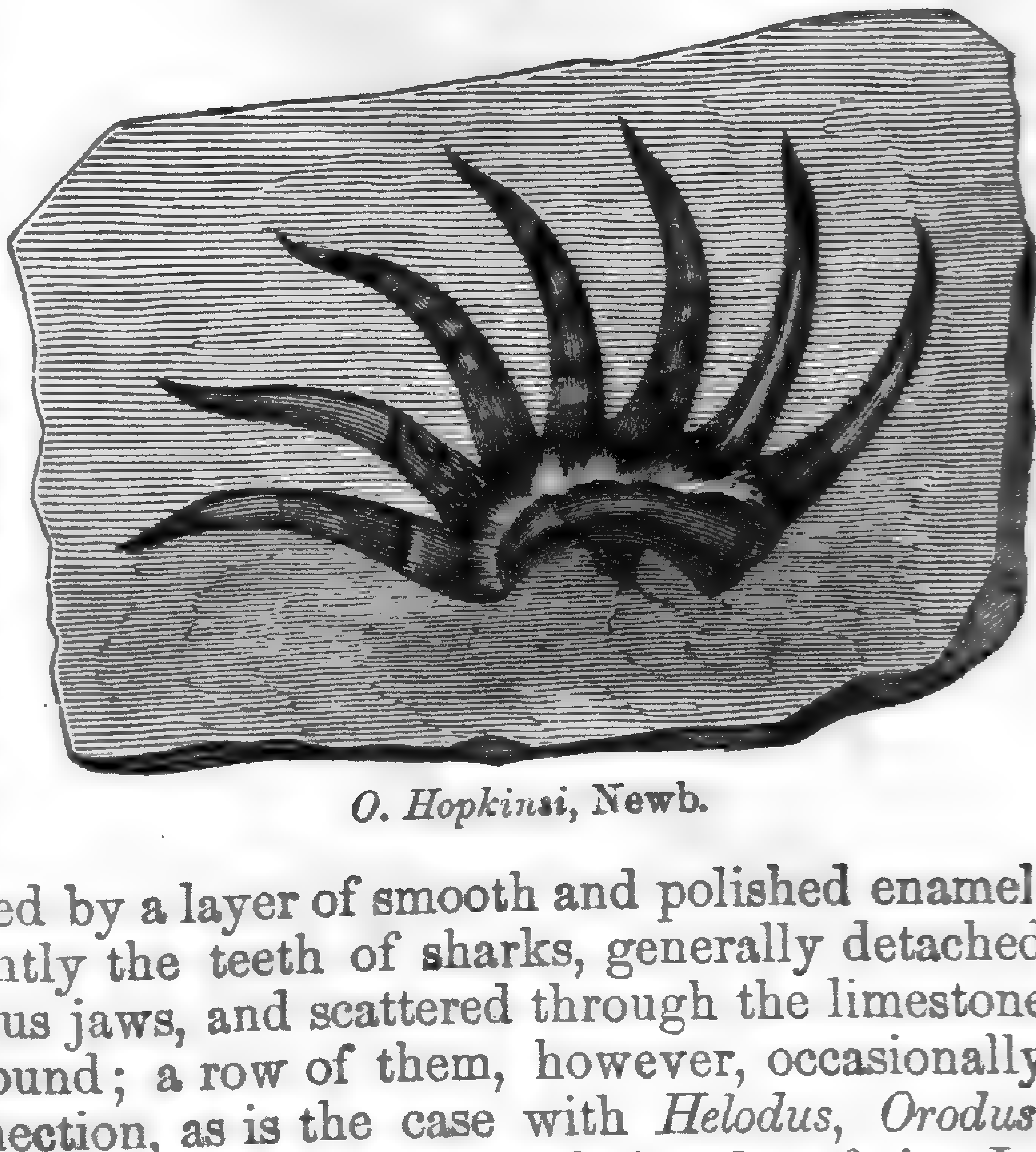
One of the smaller species of this genus is that described by Prof. Hopkins in the Proc. of the American Association, vol viii, p. 287, represented by the accompanying wood cut, taken from that volume.

These spines are very characteristic of the horizon of the Corniferous limestone; having been found in Indiana, various localities in Ohio, in New York and at Gaspé, C. E. Though presenting some anomalous characters, (among which the most remarkable is their want of symmetry, being rights and lefts), it is hardly possible they can be anything else than the defensive spines of placoid fishes. Their dense bony structure, enamelled surface, and their rough and irregular bases, would seem to prove that like the fin-spines of many sharks and rays they had been implanted in the integuments without articulation. Possibly they were the first rays of the pectoral fins, which would account for their being in pairs, but in that case we should expect to find the bases exhibiting some marks of their articulation to the thoracic arch. Some of these spines are more than a foot in length, double-edged and very sharp, constituting most formidable weapons of attack or defense. My friend Dr. Wm. Stimpson, whose knowledge of Crustacea is so minute and so general, is decidedly of the opinion that they could not have belonged to a crustacean.

Genus Onychodus, Newb.

Teeth in rows of seven or more, set upon an arched base, from which they radiate. They are much curved, have a circular section toward the summit, are somewhat compressed below, and expand at base into several prominent roots or tuberosities, of which the most conspicuous are on the side toward which the point is curved. They have a central cavity extending nearly to the point, surrounded by dentine, simple in structure, the external surface covered by a layer of smooth and polished enamel.

3.



O. Hopkinsi, Newb.

These are apparently the teeth of sharks, generally detached from the cartilaginous jaws, and scattered through the limestone in which they are found; a row of them, however, occasionally retaining their connection, as is the case with *Helodus*, *Orodus*, &c. of the Mountain limestone, *Hybodus* and *Acrodus* of the Jurassic strata.

In addition to the fishes of the Corniferous limestone enumerated in the preceding pages, fragments of the armor of large Placoderm Ganoids have been found which have been referred to *Coccosteus* and *Cephalaspis*, but more and better specimens will be necessary to prove that these genera were represented in our Devonian seas. A number of placoid spines and teeth have also been taken from the Cliff limestone of Ohio, which have not yet been described.

In the upper members of the Devonian formation, the number of fossil fishes yet discovered in this country is small. A species of *Palæoniscus* obtained by Prof. Brainard from the Portage group in northern Ohio, (*P. Brainardi*); two species of *Holoptychius* from the Catskill of New York, another with a placoid spine from the same formation in Pennsylvania, complete the catalogue.

Of these the *Palæoniscus*, described by Mr. Thomas, is apparently a good species, and is interesting from its antiquity. The two New York species of so-called *Holoptychius* have, I believe, never been critically examined, and it is by no means certain that they are such. That described by Dr. Leidy from Pennsylvania is a well marked species of this genus, evidently closely allied to *H. nobilissimus* of Europe.

It will be noticed in the foregoing sketch that no mention is made of many of the most characteristic genera of fishes of the Devonian rocks of the old world, and up to the present time we have no proof that any of the Placoderms, *Asterolepis* (*Pterichthys* of Miller), *Coccosteus*, *Cephalaspis*, *Pteraspis*, &c., of the Cœlacanths, *Homostius* (*Asterolepis* of Miller), *Bothriolepis*, *Dendrodus*, *Psammosteus*, &c., of the Dipterians, *Dipterus*, *Osteolepis*, *Diplopterus*, &c., or the Acanthians, *Acanthodes*, *Diplacanthus*, *Cheirolepis*, &c. ever had any existence in America.

The evidence on this point is of course as yet only negative, and may all be soon reversed, but it is nevertheless rather remarkable that while most of the Devonian molluscous genera, and many species are common to the two continents, the fishes so far as known are all specifically distinct, and the larger part of them generically different.

(*To be continued.*)

ART. IX.—*Experiments on the formation of Infusoria in boiled solutions of organic matter, enclosed in hermetically sealed vessels, and supplied with pure air;* by JEFFRIES WYMAN, M.D., Hersey Prof. of Anatomy in Harvard College.

PASTEUR in his admirable researches on fermentation has brought forward experimental evidence to show that this process depends upon the presence of minute organisms in the fermenting fluid and that the source of all such organisms is the atmosphere. In support of this opinion he asserts, that when a fluid containing organic matter in solution is put into a flask and "boiled two or three minutes," and supplied only with air which has been filtered by passing through a tube heated to redness, and the flask is then hermetically sealed, no fermentation takes place, no organisms are formed, and that the contents remain indefinitely without change. But if the same solution is exposed to the air in its ordinary condition, it becomes filled with various living forms. Out of a large number of experiments prepared in the manner above described he has not known one to give a different result from that mentioned.[1] He further states that if the neck of the flask is drawn out into a very slender curved tube of several inches in length, the contents boiled, and then allowed to cool without the end of the tube being closed, so that the air enters at the ordinary temperature, and has free access to the interior of the flask, even then no fermentation takes place and no organisms appear. His explanation of this is, that the air which enters first, meets with the hot steam, and the spores or organisms contained in it are killed; while those which enter the tube later move more slowly and are deposited on the moist walls of it without entering the body of the flask.[2]

In most of the experiments given below the results have been quite different, and living organisms have made their appearance, in some instances where even greater precautions were taken than those mentioned by Pasteur. In order that the reader may understand what precautions were taken we shall first describe the manner in which the experiments were performed.

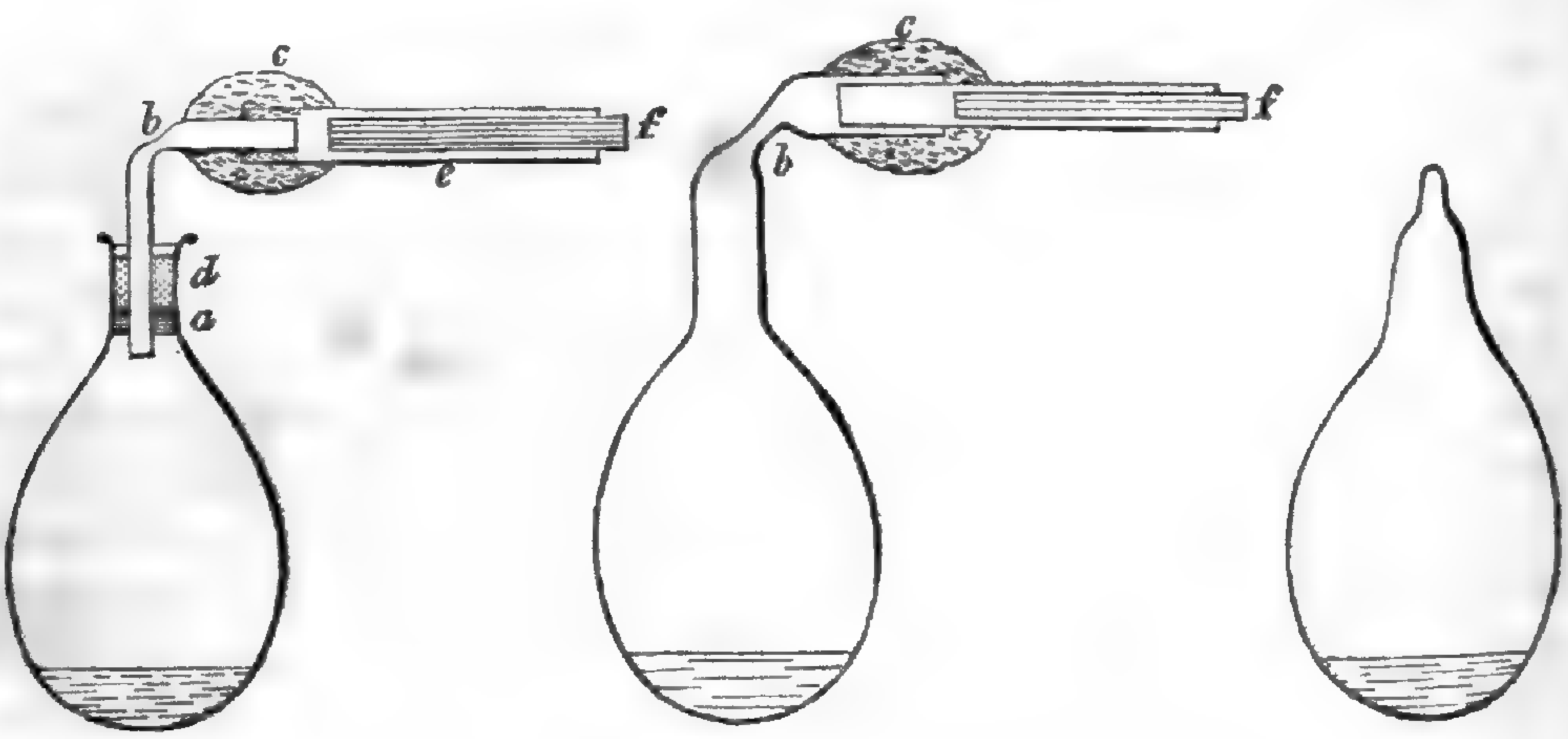
(1.) In some instances (as in Expts. i to v, vii to xi, xiii to xv,

[1] "J' affirme avec la plus parfaite sincerité, que jamais il ne m'est arrivée d'avoir une seule experience disposée comme, je le viens de le dire, qui m'ait donné un seul resultat douteux."—*Annales des Sciences Naturelles*, T. xvi, ivme Serie, 1861, p. 33.

[2] "Il semble que l'air ordinaire rentrant avec force dans les premiers moments doit arriver tout brut dans le ballon. Cela est vrais, mais il rencontre un liquide encore voisin de la temperature de l'ebullition. La rentrée de l'air se fait en suite avec plus de lenteur et, lorsque le liquide est assez refroidie pour ne plus pouvoir enlever aux germes leur vitalité, la rentrée de l'air est assez relentée pour q'il abandonne dans les courbures humides du col toutes les poussieres capable d'agir sur les infusions, et d'y determiner des productions organisées."—*Ann. des Sc. Nat.*, 1861, T. xvi, p. 60.

xxix and xxx inclusive) they were prepared as in fig. 1. The materials of the infusion were put into a flask, and a cork *a*, through

1. 2. 3.



which was passed a glass tube, drawn to a neck at *b*, was pushed deeply into the mouth of it. The space above the cork was filled with an adhesive cement *d*, composed of resin, wax and varnish. The glass tube was bent at a right angle, and inserted into an iron tube *e*, and cemented there with plaster of paris *c*. The iron tube was filled with wires *f*, leaving only very narrow passage ways between them.[3]

(2.) Others (as in Exps. vi, xii, xvi to xxiv, and xxxi to xxxiii inclusive,) were prepared as in fig. 2, in which the joining at *a*, fig. 1, is avoided, and the iron tube is cemented directly into the mouth of the flask, the neck of which is drawn out at *b*, to render the sealing of it easy; otherwise the conditions are the same as in fig. 1.

(3.) In other experiments (as in Exps. xxiv to xxviii, and xxxiv to xxxviii inclusive,) the flask, fig. 3, was sealed at the ordinary temperature of the room, and submerged during the period of the experiment in boiling water. This was the method followed by Needham and Spallanzani and has the merit of eliminating all suspicions of error which might be supposed to arise from some imperfections in the joinings.

In the first and second methods, the solution in the flask is boiled, and at the same time the iron tube filled with wires is heated to redness. While the contents are boiling the steam formed expells the air from the flask; when the boiling has continued long enough, the heat is withdrawn from beneath the flask, and as the steam condenses, the air again enters through the iron tube, the red heat of which is kept up, so that all organisms contained in the air are burned. In both methods the flask is

[3] An advantage in preparing the experiment in this way is, that the same flask may be used many times.

allowed to cool very slowly in order that the entering air may be as long as possible in passing through the iron tubes, and thus the destruction of its organic matters insured. When cold the flasks are sealed at *b*, figs. 1 and 2, with the blowpipe.

In experiments xxix and xxx, a glass tube filled with asbestos and platinum sponge was used instead of the iron tube filled with wires.

The time during which the infusions were boiled varied as will be seen by the records, from fifteen minutes to two hours, and the amount of infusion used was from one-twentieth to one-thirtieth of the whole capacity of the flask, the object being to have the materials exposed to as large a quantity of air as possible.

In the account which follows, especial mention is made, in most instances, of the time of the formation of the "film." This is always the first indication which can be had, without opening the flasks, that minute organisms are developed; it is in fact made up entirely of them, as has been proved by repeated examinations with the microscope. It may first be detected in small patches, but soon covers the entire surface, and if the flask is gently moved so as to cause the infusion to change its position, the film adheres to the glass and is left by the liquid. In a few of the experiments no such film was formed.

After the flasks were prepared they were suspended from the walls of a sitting room near the ceiling, where they were exposed to a temperature of between 70° and 80° F. throughout the day and nearly the same during the night.

Exp. I.[4] (1.)[5] Feb. 3d, 1862. A few grains each of sugar, gelatine and fine cut hay were introduced into a flask of 500 cub. cent. capacity, 20 cub. cent. of water were added and the whole thoroughly boiled. A film formed on the surface of the fluid on the 8th day, the flask was opened on the 9th and found to contain large numbers of Bacteriums.

Exp. II. (1.) Feb. 3d. This was prepared in the same way as the preceding, excepting that pepper was added to the solution. The flask was opened on the 29th day and Bacteriums were found in great numbers.

Exp. III. (1.) Feb. 4th. A few grains of cheese, sugar and gelatine were dissolved in 17 c. c. of water, filtered and boiled in a flask of 500 c. c. capacity. A film formed on the 19th day, the flask was opened on the 36th and found to contain Bacteriums.

Exp. IV. (1.) Feb. 4th. Twelve cubic centimetres of a solution like the preceding, with the addition of a small quantity of

[4] In the first seven experiments the time which the contents were boiled is not stated, but it was in no instance less than fifteen minutes.

[5] The figures in brackets following the number of the experiment indicates which of the three modes of preparing the experiment was made use of.

pepper was boiled in a flask of 250 c. c. capacity. It was opened on the 20th day, but no living organisms were found.

Exp. V. (1.) Feb. 5th. A solution of sugar, gelatine, and cheese was boiled and filtered, and again boiled in the flask, which was opened on the 29th day, and no organisms detected.

Exp. VI. (2.) Feb. 10th. A solution of gelatine and sugar to which was added a few drops of urine and milk, were put into a bolt-head, the tube of which had been drawn to a neck, and after boiling, was hermetically sealed. The flask was opened on the 13th day and found to contain yeast plants and some very slender filaments which appeared to be of a vegetable nature.

Exp. VII. (1.) Feb. 10th. Twenty cubic centimetres of a solution like the preceding was boiled in a flask of 875 c.c. capacity. A film formed on the 11th day, and on the 30th the flask was opened and found to contain Vibrios and Bacteriums.

Exp. VIII. (1.) Feb. 25th. A solution of sugar and gelatine to which fragments of green leaves and flesh were added, was boiled 1^h and 40^m. The flask was opened on the 15th day; no organisms were found.

Exp. IX. (1.) Feb. 25th. The same as the preceding, without the addition of the flesh; this solution was boiled 40′ and opened on the third day; no organisms were found.

Exp. X. (1.) March. 6th. Three flasks, *a b c*, were prepared in the same way, each containing a solution of sugar and gelatine to which was added a few drops of urine and some fragments of muscle; *a* and *c* were boiled 30′ and *b* 1^h. Air was supplied to *a* and *b* through a heated tube and to *c* at the temperature of the room. A film formed in *a* on the 11th and in *c* on the twelfth day, and at a later period in *b*. They were all opened a few days afterwards and found to contain Bacteriums, Vibrios and ferment cells.

Exp. XI. (1.) March 12th. An ounce of meat was suspended in a flask of 850 cub. cent. capacity with about 40 c. c. of water in it. This was boiled 20′, during which time the meat was exposed to the steam in the flask. The juice which dropped from the meat was coagulated in the water beneath, and the meat itself was thoroughly cooked; on the second day the meat was covered with a gelatinous exudation, and on the third a film was formed on the surface of the water. The flask was opened on the fifth day and found to contain Vibrios, Bacteriums, and a few ferment cells. The gelatinous exudation on the surface of the meat also contained the same organisms, and appeared to be wholly made up of them.

Exp. XII. (2.) March 13th. The juice of an ounce of beef, to which was added 10 cub. cent. of urine and 40 c. c. of water was boiled 20′ in a bolt-head and hermetically sealed. A film formed on the 4th, and the flask was opened on the 11th day, when there was a distinct rush of air outwards. Large numbers of Bacteriums were found, also small spherical bodies with ciliary motions and oval bodies like Kolpoda, containing what appeared to be Bacteriums; one of these Kolpoda-like bodies moved with cilia.

Exp. XIII. (1.) March 15th. An ounce of beef was suspended over water in a flask of 500 c. c. capacity and boiled 25′. The same changes took place as in the preceding experiment. The exudation appeared on the surface of the meat, and the film on the water on the 2d day; on the 4th day the meat fell to pieces; the flask was opened on the 9th day; Bacteriums were found in large numbers and there was a slight odor of putrefaction.

Exp. XIV. (1.) March 17th. Juice of beef and a few shreds of beef were boiled in a flask of 300 cub. cent. capacity for 20′. A film was formed on the 2d day and the flask was opened on the 11th day. Bacteriums existed in abundance.

Exp. XV. (1.) March 19th. Fifty cubic centimetres of beef were boiled 40′ in a flask of 800 c. c. capacity. The film began to form on the 2d day, and the flask was opened on the 24th. The film had disappeared, the fluid had a nauseous odor and the Bacteriums were diffused through the whole mass instead of being mostly confined to the surface as in the preceding experiments.

Expts. XVI, XVII, XVIII, XIX, (2.) March 20th, were made with juice of beef and water in flasks of 550 cub. cent. capacity; xvi was boiled 15′, the film formed on the second day and the flask was opened on the 9th. Vibrios were found in abundance, of different lengths, some of them moving with great rapidity. xvii was boiled 30′, the film was formed on the 3d and the flask was opened on the 9th day. Vibrios were found in great numbers, some of them bending and extending themselves rapidly. Some minute spherical bodies were also seen, having the kind of motion which results from vibrating cilia, though none of these were detected. xviii was boiled 15′, the fluid having been previously filtered; the film formed on the 3d, and the flask was opened on the 8th day; the organisms found were the same as in xvii. xix was boiled 1^h. The film formed on the 2d and the flask was opened on the 24th day. The infusion had a slightly putrid odor and contained Vibrios and Bacteriums.

Exp. XX. (2.) March 22. The flask and the contents of it were the same as in the experiments just described. The solution was boiled 15′. The film formed on the 5th, and the flask was opened on the 31st day. The fluid had become of a dark reddish brown color, the film had disappeared, and some of the shreds of the coagulated albumen had become nearly black. Bacteriums were found in large numbers, and the darker shreds seemed to be made up of them.

Exp. XXI. (2.) March 27th. Beef juice was boiled 40′; the flask was opened on the 25th day, and found to contain Bacteriums.

Exp. XXII. (2.) April 2d. Beef juice and fragments of beef were boiled 15′, and the air was introduced through a much smaller tube. Bacteriums were found on the 20th day.

Exp. XXIII, (2,) April 5th, was prepared in the same way as the preceding experiment. The film formed on the 6th day, and the flask was opened on the 17th. The sealed end was melted in the flame of a spirit lamp, when the gas escaped with force. Bacteriums were found.

Expts. XXIV, XXV, XXVI, (3,) were all prepared in the same way, April 16th. The capacity of the flasks was 550 c. c.; the contents were beef juice and water 17 c. c., urine 7 c. c. The flasks were folded in a napkin, immersed in water, which was gradually heated to the boiling point, and each then exposed to it for 30′. The film formed in xxvi on the 4th day, and in xxiv and xxv on the 5th, and were all subsequently found to contain Bacteriums.

Expts. XXVII, XXVIII. (3). April 24th. Two flasks, each of 550 c. c. capacity, and each containing about 20 c. c. of beef juice and urine, were hermetically sealed at the temperature of the room, wrapped in cloth, and exposed for two hours to boiling water. The film formed on the 4th day; one of them was opened on the 5th and the other on the 11th, and both found to contain Bacteriums.

Expts. XXIX, XXX. (1.) February 17th. In both of these the contents of the flasks were solutions of sugar and gelatine in water, to which fragments of cabbage leaves were added. The air was introduced through a Bohemian glass tube, filled with asbestos and platinum sponge, and heated to redness. The materials were boiled 30′. In xxix the film was formed on the 29th, and the flask was opened on the 39th day. The solution was found to contain Bacteriums and cells filled with them. In xxx the film was formed on the 7th day, and Bacteriums were found on the 23d, when there was a slight odor of putrefaction.

Expts. XXXI, XXXII, XXXIII. (2.) March 24th. 30 grains of sugar, 20 c. c. of beef juice, 158 c. c. of water, were divided into three parts, and each part put into a flask of 550 c. c. capacity, and boiled 15′. No film was formed in either of them. xxxiii was opened on the 30th day; ferment cells and some filaments of a doubtful vegetable appearance were found. xxxii was opened on the 42d day, and contained ferment cells and monads. An escape of gas took place when the flask was opened. xxxi was opened on the 43d day, and found to contain ferment cells in large numbers, in different stages of cell multiplication; as in xxxii, there was an escape of gas.

Exp. XXXIV. (3.) March 27th. Juice of mutton, in a hermetically sealed flask, was boiled 5′ in a Papin's digester, under a pressure of 2 atmospheres. A film formed on the 4th day. It was opened several days later, in the presence of Prof. Gray, and found to contain Vibrios and Bacteriums, some of them moving with great rapidity.

Exp. XXXV. (3.) The same as the preceding, and boiled in Papin's digester 10′ and under the pressure of 5 atmospheres. No film was formed. The flask was opened on the 41st day. Monads and Vibrios were found, some of the latter moving across the field. No putrefaction; the solution had an alkaline taste.

Exp. XXXVI. (3.) March 28th. Beef juice was filtered and boiled, as in the preceding experiment, 15′, under 2 atmospheres. Opened on the 41st day, and no evidence of life was found. When the end of the flask was heated, previously to opening, it collapsed.

Exp. XXXVII. (3.) March 28th. The same as the preceding; boiled 15′, under 5 atmospheres. Opened on the 41st day, and no evidence of life was detected.

We have here a series of thirty-three experiments, prepared in different ways, in which solutions of organic matter, some of them previously filtered, have been boiled at the *ordinary pressure* of the atmosphere for a length of time, varying from 15 minutes to 2 hours, and exposed to air purified by heat. In four instances, viz., in Expts. iv, v, viii, x, the contents of the flasks were unchanged at the time they were opened; but in all of the rest, Bacteriums, Vibrios, or other organisms appeared. In nearly every instance their presence was indicated, in the early stage of the experiments, by the formation of a film, which took place in some on the 2d, and in others not until the 19th day, and was afterwards proved by a careful examination with the microscope. Prof. Asa Gray witnessed the opening of some of these flasks, and satisfied himself of the presence of Infusoria in the contents. Vibrios, Bacteriums and Spirillums were the most frequently found, and in addition to these, as in Expts. x, xi, xii, xxix, xxxi, xxxii, xxxiii, either ferment cells, monads, or Kolpoda-like bodies were seen, some of them having ciliary movements. Those forms which were observed the most frequently are among the lowest, if not the lowest of all known organisms.

In many instances, a solution like that in the sealed flasks, and boiled for the same length of time, was exposed to the ordinary air of the room, in an open flask. Although the same forms were found in the two, they appeared much more rapidly in the open than in closed vessels, and the contents of the former soon became putrid, while those of the others, at the time of opening, were mostly not, and in a few instances only slightly so.

We have, in addition, four experiments, viz., xxxiv, xxxv, xxxvi, xxxvii, made under *increased pressure*, and sealed by the third method; xxxiv and xxxvi were boiled 5′ and 10′ respectively, under 2 atmospheres, and xxxv and xxxvii, under 5 atmospheres for 10′ and 15′ respectively. Evidence of life, consisting of Monads and Vibrios, was found in xxxiv and xxxv, but none in the others.

The result of the experiments here described is, that *the boiled solutions of organic matter made use of, exposed only to air which has passed through tubes heated to redness, or enclosed with air in hermetically sealed vessels and exposed to boiling water, became the seat of infusorial life.*

The experiments which have been described throw but little light on the immediate source from which the organisms in question have been derived. Those who reject the doctrine of spontaneous generation in any of the forms in which it has been brought forward, will ascribe them to spores contained either in the air enclosed in the flask, or in the materials of the solution. In support of this view it may be asserted, that it has been proved by the microscopical investigations of Quatrefages, Robin, Pouchet, Pasteur and others, that the air contains various kinds of organic matter, consisting of minute fragments of dead animals and plants, also the spores of cryptogamous plants, and certain other forms, the appearance of which, as Quatrefages says, suggests that they are eggs.[6] We have made some examinations of our own on this subject, but it would be unnecessary to give the results in detail. We will simply state, that we have carefully examined the dust deposited in attics, also that floating in the air collected on plates of glass covered with glycerine, and have found in such dust, in addition to the debris of animal and vegetable tissues, which last were by far in the greatest abundance, the spores of Cryptogams, some closely resembling those of Confervoid plants, and with them, but much less frequently, what appeared to be the eggs of some of the invertebrate animals, though we were unable to identify them with those of any particular species. We have also found grains of starch in both kinds of dust examined, to the presence of which Pouchet was the first to call attention. When compared with the whole quantity of dust examined, or even with the whole quantity of organic matter, both eggs and spores may be said to be of rare occurrence. We have not in any instance detected dried animalcules which were resuscitated by moisture, and when the dust has been macerated in water none have appeared until several days afterwards, until after a lapse of time, when they would ordinarily appear in any organic solution.

Those who advocate the theory of spontaneous generation, on the other hand, will doubtless find, in the experiments here recorded, evidence in support of their views. While they admit that spores and minute eggs are disseminated through the air, they assert that no spores or eggs of any kind have been actu-

[6] See an abstract of Pasteur's researches on Spontaneous Generation, this Jour., xxxii, 1, 1861.

ally proved by experiment to resist the prolonged action of boiling water. As regards Vibrios, Bacteriums, Spirillums, etc., it has not yet been shown that they have spores; the existence of them is simply inferred from analogy. It is certain that Vibrios are killed by being immersed in water, the temperature of which does not exceed 200° F. We have found all motion, except the Brownian, to cease even at 180° F. We have also proved by several experiments that the spores of common mold are killed, both by being exposed to steam and by passing through the heated tube used in the experiments described in this article. If, on the one hand, it is urged that all organisms, in so far as the early history of them is known, are derived from ova, and therefore from analogy, we must ascribe a similar origin to these minute beings whose early history we do not know, it may be urged with equal force on the other hand, that all ova and spores, in so far as we know anything about them, are destroyed by prolonged boiling: therefore, from analogy we are equally bound to infer that Vibrios, Bacteriums, &c., could not have been derived from ova, since these would all have been destroyed by the conditions to which they have been subjected. The argument from analogy is as strong in the one case as in the other.

Cambridge, May 9th, 1862.

Art. XI.—*Geographical Notices.* No. XVII.

KILIMANJARO, THE SNOW COVERED EQUATORIAL PEAK OF AFRICA.

The proceedings of the London Geographical Society, vol. vi. No. 2, 1862, contain a very important letter from Mr. R. Thornton, F.R.G.S., (lately attached to Dr. Livingstone's Zambesi Expedition as Geologist) respecting his visit, in company with Baron Carl von der Decken to the much talked of snow-covered mountain, near the equator on the eastern coast of Africa.

The existence of such a mountain, named Kilimanjaro, was reported several years ago by the missionaries of the London Church Missionary Society at Rabbai Mpia. One of them, Mr. Rebmann, saw the snowy peak for the first time in May, 1848, and subsequently saw it again. The next year in November, his colleague, Dr. Krapf, saw the same white-topped summit. Neither of them ascended the mountain,—but the natives gave an account of their experience in going up it. They said that "the silver like stuff when brought down proved to be nothing but water," and that many who climbed the mountain returned with frozen extremities which some ascribed to evil spirits. These reports awakened much ridicule in England. The existence of a snow peak was declared by excellent authority to be highly improbable; the story of the natives was laughed at, and the missionaries were said to have mistaken white stones and rock for snow. Dr. Petermann however and some others defended the probability that the missionaries were right, but on both sides there has been a desire to have the question settled.

At last we have a satisfactory confirmation that there is such a snow-covered mountain, twenty thousand feet high, more or less, lying almost exactly on the equator. Baron von der Decken, who had expected to follow up Dr. Roscher's explorations of the Southern central lakes, being frustrated in this plan, went north with the English geologist who had left Dr. Livingstone's party, and together they have visited Kilimanjaro, or Mount Ndjaro. Von der Decken has written Dr. Barth an account of their observations, (see Berlin Zeitscrift, Dec. 1861,) and Thornton has written to London. We append the letter of the latter, as we find it,—his geological observations having not yet been made public. The reading of the letter at the meeting of the Royal Geographical Society called forth some strong expressions of satisfaction from several distinguished geographers. Mr. W. D. Cooley still disputes (in the London Athenæum) the truth of the reports.

"Our route lay from Mombas to the southwest over the Shimba, thence northwest to the Kadiaro, then southwest to the Pare, then north to the Lake Yipe, thence through Dafeta to Kilema, where we made one attempt to ascend the Kilimanjaro, but had to turn back at about 8000 feet. We then went round by the foot of the mountain to Madjami; thence we returned by Dafeta, Lake Yipe, Pare, and the north foot of Usambara, to Wanga on the coast, which we reached on the 101st day from Mombas. We have made a tolerable map of our journey, the country through which we passed being very favorable for triangulation; though, from not being allowed to ascend the mountains of Pare and Usambara, and the want of two or three stations which circumstances prevented our taking, the map is not nearly so complete as I could wish it to be. The triangulation is checked by several latitudes and a lunar distance at Kilema. I have not yet plotted out the whole of the map, but I hope to complete and send it shortly.

Our journey, on the whole, has been tolerably successful. We did not succeed in reaching to top of Kilimanjaro; but I have its altitude from six different stations, connected by tolerable triangles, at distances varying from 15 to 50 miles. From these I believe the height of the Kilimanjaro to be about 20,000 feet. Its shape varies much, as seen from different points of view; but, from all places we have seen it, its base rises very gradually from a great plane. The outline of the top, as seen from Madjami, is a great dome (but this face is nearly flat): as seen from the east, it is conical, with the apex cut off, forming a little plane, sloping a little to the north. The southern slope of this cone is much steeper than the northern. Several miles to the northeast of the top a great conical peak rises to about 17,000 feet; and about 50 miles to the west of Kilimanjaro a great conical mountain, named Meru, rises from the great plain of the Massai to perhaps 18,000 feet.

As seen from the east, the snow forms only a thick cap to the Kilimanjaro, with a broad tongue creeping down the south slope; and when the sun is high, several long streaks of snow are seen lying in small ravines descending from the cap. As seen from Madjami, the snow partially covers the southwest face of the dome (about a quarter the height of the mountain), but several large bare patches of rock show out above the snow. The snow here seems to lie at its steepest possible angle, so that fresh snow falling on this slide must at once slip down to the foot of the face of the dome. In one evening, at Madjami, we saw three such slips of snow in about an hour's time. On the eastern peak a few patches of snow are seen when the sun is high.

All parts of the mountain we saw are composed of lava of subariel origin. From not reaching the top, and having seen only the southeast, south, and southwest parts of the mountain, I cannot speak with certainty of its structure; but I think that the Kilimanjaro is the northeastern part of an old subariel volcano, the southwestern and larger part having sunk down several thousand feet, and been partially broken up by faults. The great fault separating these two parts lies about northwest and southeast, and forms a very steep, long flat southwest face to the mountain; and a high, very rugged mountain mass, lying a few miles to the north of Madjami, may be the relics of the top of the original mountain.

We have not reached the axis of structure of Eastern Africa; but very far to the southwest from Kilema are seen, on a clear day, three very high rugged mountains (as high as the Meru mountain), with conical tops, which, if not volcanic—and I think their sides are too steep and shapes too irregular for ordinary volcanoes—may be composed of the axial granite.

The Lake Yipe is shallow, and rapidly filling up. You will see its size and position best when I send you our map. On its north side it receives the River Loomi (of Rebmann), and at its west end sends out a river which, after joining the Jagga river, flows south through the plain lying between the Ugona and Anuisha ranges to the river of Pangani. Between the Kilimanjaro and Anuisha ranges is a small watershed, which sends the rivers of Western Madjami to the west.

Mr. Rebmann's map and description, as given in the first volume of the 'Missionary Intelligencer,' give a very fair idea of the country, and, considering he had no instruments, his map is very accurate."

LIVINGSTONE'S EXPEDITION.—THE ROVUMA RIVER.

1. The following letter has been published from Dr. Livingstone dated April 9, 1861. It appears in the Proceedings of the London Geographical Society, vol. vi, No. 1.

"On the 9th of April last, Dr. Livingstone's expedition arrived at Pomony Bay in the island of Johanna, from the river Rovuma. They had ascended the river only 30 miles, when, halting to wood their ship, a mark made on a tree showed that the water was falling at the rate of

6 or 7 inches a day. They had found some parts carrying no more than 5 or 6 feet of water, and as they drew nearly 5 feet, they had to return, lest they should be left fixtures till the flood of next year. The cause of this unsuccessful termination is to be attributed to various delays suffered by the *Pioneer* in the voyage out, making her at last quite two months behind the time for a successful trip up the river. After coaling, they left for the Zambesi, intending to go up the Shiré, and then make a road past Murchison Cataract on that river to Lake Nyassa. The distance is only 35 miles, and it is hoped that they will carry a boat up above the cataracts, and by that means explore the lake.

It is also in contemplation to settle the point whether the Rovuma comes out of the Nyassa, as asserted by all the people they met, before going in the *Pioneer* again to that river. The Oxford and Cambridge Mission accompany the expedition up the Shiré, and it is proposed to place these gentlemen on the plateau of 4000 feet above the sea, on which stands Mount Zomba. There they are likely to enjoy good health while pursuing their enterprise. They have had a good deal of fever, but no mortality. The healthy season begins in May.

The Rovuma will probably turn out to be the best entrance into Eastern Africa. It must, however, be navigated with a vessel of light draught, and with the same skill as is required in the London above-bridge passenger-boats. On the question whether it actually derives its waters from Nyassa, the Doctor thinks that it cannot come out of the Nyassa he discovered, but from some other lake. The reasons he adduces are: the Nyassa is already known to give off one large river the Shiré. This river never rises nor falls more than 3 feet, nor is its water ever discolored. The Rovuma rises and falls 6 or more feet, becomes very muddy, and no instance is known of one lake giving off two large rivers. The probability, therefore, is, that if the Rovuma does come out of a Nyassa or Nyanza (lake, or piece of water), it is some other than that discovered by the expedition. It is well known that lakes having no outlets become brackish in the course of ages. This is the case with Shirwa, but Nyassa and Tanganyika are sweet. The former owes its sweetness to the Shiré flowing out of it. Does Tanganyika owe its sweetness to the Rovuma?"

2. The same number of the Proceedings contains an interesting report, extending through several pages, from Mr. John Kirk, Botanist of the Livingstone expedition, chiefly in respect to such vegetable products of the Shiré and lower Zambesi Rivers, as are in demand in Europe. He reports much of this region as favorable to the growth of cotton, sugar, ground nuts, indigo and cereals. India rubber, coffee, ebony, lignum vitæ are also produced. We copy a few paragraphs on the productions of the Zambesi delta, chiefly for what it says of the cotton culture.

"The countries examined have been those bordering the Zambesi from the east coast to Sesheke, a Makolo town, situated in the centre of the African continent; likewise the valley of a tributary river, the Shiré, from Lake Nyassa to its confluence with the Zambesi near Moramballa Hill. The highlands of the Batoka and Manganja countries have also been visited. The area thus included extends over 11° of longitude and 5° of latitude; the greatest height above the sea level being 8000 feet.

The Zambesi forms a large Delta, commencing 60 miles from its mouth; the coast for about 8 miles inland is muddy, wooded with mangrove, avicennia, and other trees peculiar to such places within the tropics; the remainder of the Delta consists of rich flat alluvial lands, intersected by many branches of the river. This great tract is covered almost exclusively with gigantic grasses, which keep down all other forms of vegetation, only borassus palms, with a few figs, acacias, or lignum vitæ trees, being able to resist the fires which sweep over these plains during the dry season. The people at present inhabiting the Delta are for the most part fugitives; the slave trade and war have combined to desolate this rich country, which once produced corn, vegetables, and fruits in abundance. Near the coast cotton of an inch staple is found growing wild, having sprung up from seed accidentally scattered; this equals in value much of the Egyptian. Climate and soil are admirably suited, seeing that the plant succeeds so well without cultivation, surrounded by weeds. In the more inland districts it could not raise its head above the dense luxuriance of the other vegetation. The labor required to cultivate cotton here is very small, and the Delta might be made a vast cotton field by encouraging the natives to industry. Many parts of these lands are also suited for the growth of the sugar cane; a little is now raised near the coast, and succeeds well; and it might be raised in most parts even without irrigation. Besides sorghum, pennisetum, maize, setaria, eleusine, and various other sorts of native corn, the Delta also yields wheat during the cold season. Rice of good quality is also cultivated. Tropical fruits succeed well, and near the coast mangos, pine-apples, guavas, cashews, lemons, oranges, and cocoa-nuts are still found where Portuguese settlements had existed in former times.

The climate of the Delta is mild, presenting neither the excessive heat nor cold of the interior; the atmosphere is much moister, and heavy dews are frequent; the prevalence of a sea breeze renders the parts near the coast more healthy than those within the mangroves. The malaria, although an obstacle to the settlement of Europeans, is by no means so intense as that of the west coast; and we have not found a case which resisted treatment, while a cure is commonly effected on the third day. To those passing through or remaining for a short time, there seems to be no danger. But in order that this might become an extensive source of cotton, the permanent residence of Europeans is not necessary; if it were raised by the natives and purchased from them by agents, a steady supply might be depended on; but time would be needed, even under a wise government, to bring the Delta back to a flourishing state." * *

"*Cotton.*—There are two species of the cotton plant cultivated in the countries explored: one of these, known as *Tonje Kaja*, has been in existence for a long time, and may be indigenous; no trace of its introduction can be found; it is found everywhere, but is being replaced by a better sort named *Tonje Manga*, which signifies foreign cotton, and is of modern introduction, having come from the various towns on the east coast. A variety of the Tonje Manga is met with in the interior of the continent, but not found much further east on the Zambesi than the confluence of the Kafué. This may have been introduced from the west coast.

The Tonje Kaja is, according to situation, either perennial or annual; on the Manganja Hills it is an annual from 2 to 4 feet high, sown in March and gathered in August. In the valleys it forms a shrub, remaining several years in the soil. It is readily known from the other sort by leaf and seed. The cotton is of very short staple, seldom exceeding half an inch; it very much resembles wool, and adheres strongly to the seed, from which it cannot be entirely removed: this renders it much more troublesome to pick, and an iron roller is employed to facilitate the separation.

The plant is much less prolific than the other, and the only good quality possessed by it is superior strength, on which account some still prefer it. It is the most universally distributed, being seen everywhere from the coast to the valley above the Victoria Falls and along the course of the Shiré. In the region shut off from the coast by Lake Shirwa, it becomes the only sort grown; but the foreign kind is advancing from both north and south, and fast displacing it.

Tonje Manga, the sort of recent introduction, is, like the other, annual or perennial; it is superior in every respect, and attains a much greater size. The staple varies from half an inch to an inch and a quarter, has great luster, and separates from the seed, which has a clean black coat. What is now produced on the Zambesi and Shiré equals much of the Egyptian, and might be improved by the judicious selection of seed. But there is no necessity for the introduction of new seed, what is now grown on the Shiré being of good quality and very prolific. The variety of Tonje Manga found in the central African valley above the Victoria Falls and as far down as the confluence of the Kafué, differs in the cohesion of the seeds of each cell which form a mass, from the exterior of which the cotton separates easily. The plant attains a great size, and continues seemingly for an indefinite time. Among the ruins of the old town of Sesheke a single plant was measured with a woody stem 8 inches diameter and covering a space of 12 feet. This year it had yielded an abundant crop of cotton ¾ of an inch in fiber.

Having found cotton throughout the whole extent of country explored, we know what quality may certainly be obtained, while much more may be expected from careful cultivation. The only cotton seed brought by us, superior to that already in the country, was the Sea Island variety: this yielded excellent cotton 1½ inch long when grown under the most disadvantageous circumstances, and the plant still continues at Tetté, although uncared for. Nowhere have we seen cotton which would not be worth exportation, but the best is that of the Manganja country, where the people have given it much attention; thence it might also be exported with least expense, while Europeans, settled in the neighboring highlands, could direct and superintend the natives of the valleys.

The Delta is excellent cotton ground, but unfit for Europeans, and the present population is very thin and unsettled. Beyond Kebrabassa the Zambesi valley both below and above the Victoria Falls, with the Batoka highlands, might produce a vast supply, and the Batoka hills present a healthy station for residents; but the difficulties at present connected with the rapids of Kebrabassa render this an inferior position in which to commence such an undertaking, which is to be regretted, as the people of the interior seem more disposed to industry than those of the coast. The specimens of cotton contained in the collection sent to the Royal Gardens at Kew exhibit fully the different qualities found on the Lower Zambesi and on the Shiré. Since then, others have been added from the interior, showing that the cotton grown there is but little inferior."

3. Following this report of Mr. Kirk, is an entertaining account by Mr. Charles Livingstone of the Batokas and the country they inhabit, lying between the 25th and 29th degrees E. long., and 16th and 18th degrees S. lat.,—west and north of the Zambesi.

YORUBA AND THE NIGER VALLEY.

The British government for a number of years past has bestowed much attention upon the commercial aspects of Western Central Africa, and especially upon the region bordering upon the Gulf of Guinea, including the Valley of the Niger and its great confluent the Benue, and also the countries west of these rivers, comprising Yoruba, Dahomey and Ashantee.

1. The expedition of Dr. Baikie up the Niger has been repeatedly mentioned in these notices. Although it gave promise of important results, we have but little information in respect to what it has accomplished and there is reason to apprehend that it has failed to perform what was expected. Dr. Baikie has been recalled by the Foreign Office, and his apology for not complying with their order has recently been made public.

2. Two intelligent men of color from this country, Dr. M. R. Delany and Mr. Robert Campbell, having visited the Yoruba district with a view to ascertain its fitness for African colonists from the United States, have done much to awaken an interest in that part of Africa and to direct the attention of observing persons to its commercial capacity. A volume published by the latter and a pamphlet by the former of these travelers have contributed to this result. Their impressions of its attractiveness to colonists are decided, and they urge upon their countrymen to go out and engage in trade and manufacture under formal assurances of welcome and protection from the chiefs of Abeokuta, the chief town of Yoruba. Since the return of Messrs. Delany and Campbell at the end of 1860, the condition of our country has been such as to absorb completely the attention of those who would otherwise have been interested in their statements. But public men in England, with their usual commercial sagacity, have been quick to recognize the opening of a new and rich centre of trade, and to appreciate the importance of establishing over it the influence if not the dominion of British power. Shortly after, perhaps in consequence of the publication of Dr.

Delany's observations, the British government seized the little island of Lagos, which is the key to the rich Yoruba lands. Since the seizure, various explorations have been made of the adjacent country. It is not the place to discuss here the political objects of these investigations, but they are well worthy of notice.

3. Captain Richard Burton, the well known traveler, having returned to England from his visit to Salt Lake City, Utah, has been appointed British Consul at Fernando Po. His energy and his practical acquaintance with the difficulties of African travel will enable him to help forward efficiently, from that post, investigations of the interior. He has signalized the beginning of his consulship by visiting Abeokuta, and making in connection with Captain Bedingfield, a minute survey of the River Ogun, on which the town is situated. His visit was made in October and November last. The mouth of the Ogun or Abeokuta he found very much choked up by the delta deposits and the growth of grass,—but beyond he found the main river, a goodly stream one hundred yards broad, skirted by fine forests and little affected by the tide. A brief account of his journey was communicated in a letter to Dr. Norton Shaw and printed in the Proceedings of the London Geog. Soc., vol. vi. no. 2. His impressions of Abeokuta were not very agreeable, but he confirms the estimate of its immense size, saying that travelers have underrated its population at 100,000,—it is probably 150,000. Dr. Delany estimates the number of inhabitants at 110,000; Mr. Bowen, in his "Central Africa," at from 60,000 to 100,000. The extreme circumference of the walls is about 27 miles. We make one extract from Burton's short and rambling letter.

"There is no mistake, however, about cotton growing in these regions. It can be carried out all over Yoruba; a kingdom once extending from the Volta river to the Niger, and including Benin and Dahomey: but, to give it due extension, wars must cease and treaties must be made with the several chiefs. I would here correct a mistake, universally made by those who have written upon the subject. The land is not, as stated by Mr. Campbell and others, common property, nor will the people allow strangers to take it. Litigation upon the subject is quite as general as in England; and if, as Sir Culling Eardley proposes, free negroes and mulattos were sent here from America, there would follow the agrarian wars and troubles of New Zealand. Even in the towns a stranger cannot obtain building ground, except it be granted with the understanding that it is not alienated in perpetuity, but shall revert, when no longer in use, to the original proprietor.

If you want a colony in West Africa, send it to me, near the Cameroons. At some future time I will (D. V.) enter fully into the subject. Suffice it to say for the present that Lagos requires a sanatorium—the nearest now being Teneriffe and Ascension: and the Oil rivers want a key, after losing Fernando Po. At Abeokuta the cotton is grown in the farms. I was shown the green seed or upland (short staple), and the black seed or long staple. There is, moreover, a very valuable kind, called "akashe," soft as silk. Eight seeds are sold for a penny. Before the war, the export was doubling every year; since then it has declined. The Cotton Association of Manchester exported 20,000 bales in 1859–60, and received only 3447. With the return of peace it will revive. The wars are conducted in the usual African style. Seventeen thousand men meet, blaze away with "long Danes" from the hip all the day, retire and advance, as if by mutual consent, and separate with the loss of half a dozen killed and wounded: and this stuff they call fighting! It is serious only to the allies, who, being weaker than those who assist them, are sold off by way of commissariat. The Egbas of Abeokuta are nominally fighting to defend their friends the Ijáyes against a common foe, the Ibadans. It is generally asserted that the unhappy Ijáyes have at this time lost 20,000 of their number by famine and the slave market. The real *casus belli* lies deep; the Abeokutans are determined to monopolize transit dues by keeping the northern people from the coast. Every African tribe knows that it cannot prosper without seaboard, and then the war began."

4. Commander Dolben, R. N., in H. M. S. Bloodhound, has recently visited the river Volta, which empties into the Gulf of Guinea, near Lagos, a little west of the Ogun river. He found the bed not impassable, as had been reported, but covered with eleven feet of water. Four of his boats manned by thirty nine men went up the river in October last. The party ascended the stream 120 miles when their voyage was brought to an abrupt close by rapids.

"Though impracticable to ship's boats, the rapids are not absolutely impassable, for the small strong native canoes can be forced through them to Pong, a town which is situated at their head, 5 miles above the furthest point reached by the expedition. Above Pong the Volta is again navigable. Its stream was considerable. Immediately below the rapids it had a depth of 10 feet right across from bank to bank and a width of three-quarters of a mile. The natives were a fine race of men. The climate appeared healthy; for none of the party suffered during the five days they were in the river, notwithstanding exposure and severe work. The principal products were cotton, palm oil, Indian corn, and cassava. The water of the river was palatable, and fish abundant."

DR. HAYES'S ARCTIC VOYAGE.

Dr. Hayes's engagements have been such that no full record of his voyage to the North has yet been prepared. In a private letter received from him he says that the report of his remarks published in the Proceedings of the American Philosophical Society is the most trustworthy account of his journey. "One thing," he continues, "does not appear to have been noticed which is of some national importance, though of none commercially. The land which I discovered and surveyed during this cruise is the most northern land known on the globe. I have traced it to 82° 40′ and have planted the flag of the Union ('with not a single star erased') upon it."

METEOROLOGICAL RECORD AT KANAGAWA, JAPAN, 1860.

In the absence of much trustworthy information in respect to the meteorology of Japan, the following table, recently communicated to us in the Japan Herald, vol. i, No. 2, possesses interest. The Register was kept by Rev. Mr. Hepburn, a missionary of the American Presbyterian Board. We understand that he continues to keep a like record. It is to be regretted that a barometric register does not accompany the other observations.

Table of Meteorological Observations at Kanagawa, from 1*st November*, 1860, *to* 1*st November*, 1861.

	Average of Thermometer at sunrise.	Average of thermometer at 2 P. M.	Maxim'm of thermometer for the month.	Minimum of thermometer for the month.	No. of clear days.	Cloudy days.	Rainy days.	Inches of Rain.	No. of shocks of earthquake.	Snowy days.	Inches of Snow.
1860.											
November.....	45·80	58·36	68·00	36·00	18	7	5	1·85	4	..	....
December	38·86	50·87	71·00	22·75	19	4	7	3·40	2	1	50·00
1861.											
January.......	33·00	43·30	55·00	26·50	12	12	3	4·21	1	4	8·50
February......	37·50	47·00	69·00	27·00	12	4	11	4·20	4	1	2·25
March	39·00	52·00	64·00	31·00	13	8	9	3·95	2	1	....
April.........	53·00	62·30	73·00	39·00	4	11	15	9·26	2	..	....
May..........	60·00	69·30	76·00	44·00	10	10	11	5·42	1	..	....
June.........	69·00	79·00	88·00	60·00	15	3	12	9·83	3	..	....
July..........	76·00	85·00	91·30	71·00	15	8	8	1·33	2	..	....
August	79·00	87·00	90·00	75·00	17	4	10	4·79	1	..	....
September	71·00	87·00	89·00	61·00	13	6	11	4·54	2	..	....
October.......	58·30	67·30	75·00	47·00	11	7	13	6·50	2	..	....
Yearly average.	55·03	65·70			159	84	115	59·28	26	7	11·20

SCHLAGINTWEIT'S INDIA AND HIGH ASIA, VOL. II.

The second volume of the text and the second number of the atlas of the truly imperial work on India by the Brothers Schlagintweit has recently been given to the public. The text is devoted to the Hypsometry of the regions visited. It contains in all the heights of 3,495 points, of which 1,615 belong to India, and 1,880 to High Asia, the area over which they are distributed extending from the southern part of Ceylon to the environs of Kashgar in Turkistan (from 6° to 39° N. lat.) and from the Eastern boundaries of Assám to Sindh (from 97° to 70½° long. E. Gr.). The authors state that of the 3,495 points above mentioned there are 1113 for which they had no other determination than their own; of these new data 378 belong to India and 735 to High Asia. Besides these they had occasion to add 144 points, some of which were determined anew and others were points for which differential values only had been formerly given and which were now connected with the level of the sea. It is said to have been a matter of serious consideration how to arrange so large a number of heights,—and the plan finally adopted does not seem to us free from weighty objections. India and High Asia are divided into Areas, upon principles which the authors do not mention. Through each of these eleven areas, a line is drawn connecting some of the principal places, and the succession of the heights determined to the right and left of this line, follows its mean direction as indicated by an arrow. These areas are designated as meridional, longitudinal, diagonal or transversal according to the relative position of the leading lines, and are enumerated as follows:

A. India.

Area I. Assám and delta of the Brahmapútra and Ganges, with the Nága, Khássia and Gárra hills, and some remarks about the Iravadi.

Longitudinal, from east to west: Brahmakúnd viâ Rajmahál to the Sănderbans.

" II. Hindostán along the Ganges. Longitudinal, from west to east: Saháranpur viâ Khánpur to Rajmahál.

" III. Pănjáb to Gujrát. Meridional, from north to south: Atak viâ Mithánkōt to Diú.

" IV. Central India. Meridional, from north to south: from the Ganges viâ Nágpur and Chánda to Koríngа.

" V. Dékhan and Maissúr. Diagonal, from northwest to southeast: Bombay viâ Púna and Bellári to Madras.

" VI. Karnátik and Nílgiris, with an appendix on Ceylon. Longitudinal, from west to east: Madras viâ Bangalur and Utakamand to Kalikat.

B. High Asia.

Area VII. Himálaya of Bhután, Sikkím, and Nepál. Longitudinal, from east to west: Bhután viâ Darjíling to west of Kathmándu.

" VIII. Western Himálaya, from Kámáon to Hazára. Diagonal, from southeast to northwest: Almóra viâ Símla and Srinagger to Rajáur.

" IX. Central chain of Western Tíbet. From southeast to northwest: east of the Mansaráur lake to Skárdo.

" X. Principal snow peaks of the western parts of the Karakorúm chain. From east to west: east of the Namur lake to west of the lake Sirikúl.

Area XI. Transversal sections across Tíbet, partially continued across the Kuenlúen. *a.* Níti—Gártok. *b.* Vángtu—Pangkóng. *c.* Kárdong—Karakorúm chain. *d.* Pádum—Leh. *e.* Múlbe—Kiúk Kiol—Elchi. *f.* Dras.—Shígar—Yárkand. *a–e*, are diagonal lines from southwest to northeast, *f*, is a meridional line from south to north.

These lines are considered to be situated in the centre of an area, limited by half their mutual distance.

At the conclusion of the tables of measurements which occupy the greater portion of the volume, some general remarks are made in respect to (A.) the different varieties of Elevated Habitation, (B.) the Geographical Configurations, and (C.) Physical Phenomena.

The volume of plates which accompanies this text contains several Panoramic Profiles of the snowy ranges of High Asia, and six landscapes beautifully printed in oil colors.

Following these Geographical Notices, will be found an extract from the text presenting in a condensed form the general conclusions of the authors on the Indian Himalayan hypsometry, with comparisons of the Alps and Andes.

UNITED STATES GOVERNMENT SURVEYS.

For the following information the readers of the Journal are indebted to Dr. F. V. Hayden.

The following is a brief synopsis of the contents of the several scientific reports, either already prepared or in an advanced state of preparation, for the U. S. Government:

(1.) *North-Pacific Exploring Expedition*, under the command of Commodore John Rodgers, U. S. N. The war has interfered with the completion of this report, as the Commander of the Expedition, with several of his officers, are in active service on the Southern coast, and the appropriations for the department of Natural Science have ceased. The narrative by Capt. Rodgers has not yet been written. Many charts of portions of the Chinese and Japanese seas, and also of parts of the N. E. Asiatic coast to the Aleutian Islands, are finished.

The following reports on the Natural History are in progress: On the Zoology, by Dr. Wm. Stimpson, assisted by Dr. A. A. Gould, Mr. John Cassin, Dr. Hallowell, Dr. Uhler, Mr. Barnard and Prof. Theo. Gill. The zoological portion will probably comprise about 3 vols. 4to, with an atlas of plates for each.

A Report on the Botany, by Prof. Asa Gray and Charles Wright, is in progress.

(2.) *San Juan Exploring Expedition*—Col. J. Macomb, U. S. Topographical Engineer, commanding. A very beautiful map of the region explored has been constructed, comprising Northern New Mexico and Southern Utah. The report of Col. Macomb is not yet completed, as he is at this time in active service with the Army of the Potomac.

The Geological Report by Dr. J. S. Newberry is finished. The Carboniferous fossils and fossil plants are described by Dr. Newberry, and the Cretaceous fossils by Mr. F. B. Meek. The whole occupy ten quarto plates.

(3.) *Report on Wagon-road Routes in Utah Territory*, under the command of Capt. JAMES H. SIMPSON, Topographical Engineer, U. S. A. This report is quite voluminous, 2 vols. 4to, finely illustrated with plates of scenery, Indians, &c., including a narrative, itineraries, tables of temperature and weather, vocabularies of the Indian languages, maps and charts, by Capt. SIMPSON; a detailed Geological memoir by Mr. H. ENGELMANN; Palæntology, by F. B. MEEK, with 5 quarto plates of fossils; a report on Fishes, by THEO. GILL; Birds and Mammals, by Professor S. F. BAIRD; Botany, by Dr. GEORGE ENGELMANN, of St. Louis. This report has been completed for over a year, and is now in the hands of one of the Congressional Committees, awaiting the order of Congress for its publication.

(4.) *Explorations in Nebraska and Dakota, in the years* 1855–56–57, by Lieut. G. K. WARREN, Topographical Engineer, U. S. Army. Two brief preliminary reports have already been published by the U. S. Government. Whether the entire report will be printed will depend upon the action of Congress. The work will doubtless be resumed again after the war. The Report in progress consists of the narrative of the different expeditions—three in number,—Astronomical, Barometrical and Meterological observations, and maps, profiles, &c., by Lieut. Warren; a report on the Geology of the district traversed, by Dr. F. V. HAYDEN, (completed); Palæontology; report on the Molluscous fossils, 45 quarto plates, over 1,000 figures, between 400 and 500 species new to science, by F. B. MEEK and F. V. HAYDEN, (completed); report on the Fossil plants, by Dr. J. S. NEWBERRY, about 25 plates, 4to, and from 60 to 70 species new to science; Report on the Fossil Vertebrata, by Prof. JOSEPH LEIDY, 10 plates, 4to, (prepared); Reports on the Zoology and Botany, by various authors.

(5.) *Report of the North-West Boundary Survey*—ARCHIBALD CAMPBELL, Esq., Commissioner. The field work of the survey of the North-West Boundary has been completed, furnishing data for a topographical report, embracing the country from the Pacific Coast to the summit of the Rocky Mountains, extending to the north and south of the 49th parallel, north latitude. Astronomical observations locate the Boundary at all the important points, and the surveys and actual measurements connecting these points, extending over 9° of longitude, embrace the topography on and near the line, while the reconnaisances extend to the north and south, thus affording data for the maps that are now in progress to illustrate the report. The report will consist of magnetic observations for declination, also observations for dip and horizontal intensity, made at nearly all the astronomical stations; and, finally, a magnetic survey, extending from the line near the summit of the Rocky Mountains along the usual route of travel, in a southwest direction, to Walla-Walla, crossing several lines of equal degrees of magnetic declination and dip, over a distance of four or five hundred miles.

Meterological observations have also been made at all the camps; a continuous record kept at the principal depots, as at Simiahnoo, for three years and at Colville depot during eighteen months, furnishing corresponding observations for the barometrical readings taken by the different parties along the line and other routes of travel, thus affording the material not only for a report on the Meteorology of the country, but also for barometrical profiles of the different routes. The work will also be illustrated by a number of views, showing the physical character of the country.

During the progress of the work the eclipse of the sun of July 18th, 1860, occurred, and every exertion was made to secure observations as complete as possible, with a view not only to the difference of longitude along the line, but also to their value as a contribution to science. As the eclipse occurred early in the working season, and the parties were at that time in the most rugged portion of the country, it was with great difficulty that they could reach suitable points on the boundary in time. However, the two astronomical parties were able to get in position, but on account of an unavoidable accident to some of the delicate instruments, only one of the parties succeeded in obtaining observations, and these were made at Camp Mooyie in approximate lon. 116° 10′, west of Greenwich.

In the department of natural history reports have been finished, or are in progress, of the following gentlemen:

Botany, by Dr. John Torry; Fossil Plants, with plates of new species, by Dr. J. S. Newberry; Marine Invertebrata, excepting Mollusca, by Dr. Wm. Stimpson, with plates; Recent Shells, with plates, by Philip P. Carpenter; Fossil Invertebrata, with plates, by F. B. Meek; Fossil Infusoria, Mr. Arthur M. Edwards; Fishes, with the exception of the Salmonidæ, Theodore Gill, with plates; Monograph of the Salmonidæ, Dr. George Suckley, with plates of new and unfigured species; Birds, by Dr. George Suckley and Elliot Cowes, with special monographs of the Grouse family, by Dr. S., and of the Gulls, Divers and Grelles, by Mr. C., illustrated with plates showing the specific differences of these complicated families; Report on Mammals, by Dr. Suckley, with monographs of some of the smaller animals, by Prof. S. F. Baird; Coleopterous insects, by Dr. J. L. Leconte, and non-Coleopterous, by Mr. P. R. Uhler; several reports on the Geology of the country explored, by George Gibbs.

(6.) *Explorations of the Upper Missouri and Yellow Stone, during the years* 1859–60, under the command of Capt. Wm. F. Raynolds, Topographical Engineer, U. S. A. The progress of this report has been suspended for a time, the commanding officer being on duty, as Topographical Engineer of Gen. Rosencrantz's staff. A map of the region explored has been prepared, and the Astronomical, Barometrical and Meteorological observations, with profiles, &c., are completed. The following reports are nearly ready: Reports on the Geology of the district examined, by F. V. Hayden; Palæontology, by Prof. Leidy, Dr. Newberry and Messrs. Meek and Hayden; Zoology, Mammals, by F. V. Hayden; Birds, by Elliot Cowes; Fishes, by Theo. Gill; Botany, by Messrs. Engelmen, Dewey, Sullivant and Tuckerman; also a Report on the Ethnography and Philology of the Indian tribes of the Missouri Valley, by F. V. Hayden, (finished).

[It is now probable that the Government will be soon able to resume these and other important scientific labors, as soon as the discharge of the officers before engaged on them from active military service shall render it possible to go forward again with peaceful labors. It is a circumstance of happy augury for science that during the progress of the present war, the Government has found on numerous occasions the value of its labors in science, equally in the data before recorded and in the personal services of those whose experience in the various departments of scientific training in the Government service has enabled them to serve their country with an intelligible efficiency not otherwise attainable. Hereafter we have a right to expect less unwillingness on the part of Congress to the measures involving expenditures for scientific purposes. If it were needful it would not be difficult to unite the plea of science to public consideration as demonstrated by the campaign experiences of the last fifteen months.]

ART. XII.—*H. and R. de Schlangintweit on the Geographical Configurations of India and High Asia.**

1. PLATEAUX AND LAKES.

Plateaux, in consequence of their being more or less intersected by deep and broad valleys, or from being covered with ridges, are so variable in their form, that the use of the name, in many instances, appears to be somewhat arbitrary. We prefer not to extend the meaning of the name too far, and in so doing diverge from the practice of earlier travelers, who commonly applied the term to every mountainous region of great *general* elevations—as the natives of the Himálaya have a tendency to do—irrespective of its form.

In *India* there are many plateaux, which, for the most part, lie in the Dékhan, Maissúr, and Málva; they are well defined, but of low elevation, and very limited in extent as compared with those of the Andes or Turkistán. Among the most important are Mahabaléshvar (4,500 ft.), Amarkántak (3,590), and Kondikónda (3,070 ft.).

In the *Himálaya*, which is composed in almost every direction of lofty and irregular ridges, and intersected by numerous valleys of inconsiderable width, no plateau of any extent has been discovered as yet, nor is it at all probable, that one exists.

Western Tibet was for a long time supposed to be little else than a country of plateaux—an erroneous impression emanating from the first observers, though Humboldt, with his usual sagacity, had early pointed out the error of this belief. Plateaux certainly

* Extracted from the Results of a Scientific Mission to India and High Asia by H., R., and A. de Schlagintweit, vol. ii. 4°. Leipsic, 1862.

do occur in Tíbet; they are, however, much less numerous and considerably smaller than we had been led to expect.

Tíbet may be best described, in short, as a longitudinal valley included between the Himálaya and Karakorúm, and covered with many lateral ridges.

In its *eastern part* it is drained by the Dihóng, an affluent of the Brahmapútra. The heighth of its capital, Lhássa, may be estimated at 10,000 ft.

Its *central part* is formed by the gradual rising of the ground in the environs of the lakes Mansaráur and Rákus Tal, the average height being 15,400 ft.

The *western part* is drained by the Indus and Satlej rivers, with their affluents; it comprises Gnári Khórsum, Ladák and Bálti. The principal towns of these provinces are: Gártok (15,090 ft.), Leh (11,527 ft.), and Skárdo (7,255 ft.).

The unusual height of some of the valleys of Western Tíbet, as compared with those in other parts of the globe, may not improbably have a considerable share in the erroneous belief deduced from early reports as to this country being almost exclusively a plateau.

Instances of two river-systems belonging to one general longitudinal depression are not unfrequent on a minor scale, though Tíbet must be considered perhaps as the largest form of this kind. In the Alps, the Upper Engadin with the Val Bergell, and the valley of the Vorder-Rhine with that of the Rhône, can be mentioned as somewhat analagous.

Between the *Karakorúm* and the *Kuenlúen*, especially near the western crest of the former, several well defined plateaux of extraordinary height occur. Some of the highest are called: Dápsang (17,500 ft.), Búllu (16,883 ft.), Aksáe Chin (16,620 ft.), Vohàb (16,419 ft.). In Bálti, the plateau Deosái is 14,200 ft. high.

In the *Andes* are to be found, if not the highest, at least the most extensive plateaux of our globe, which generally lie along the very ridge of the mountains. Their average heights differ but little from those of the towns mentioned above.

There is also a large plateau surrounding the elevated lake Titicaca (12,843 ft.).

In the *Alps*, plateaux occur only at their base; the Swiss plateau having a mean height of 1,460 ft., the Suevo-Bavarian plateaux of 1,420 ft.* It is here that the principal Alpine lakes are situated. In the Himálaya there are no such picturesque plains adorning the foot of the mountains. The watershed between the Indus and the Ganges is altogether upon a lower level and no connection with the Himálaya exists, similar to that between the Swiss plateau and the Alps.

* Hermann and Adolphe: "Phys. Geogr. d. Alpen." Vol. ii. p. 577.

Lakes are comparatively rare in India, but large "Jhīls" are occasionally to be seen, especially in the river systems of the Ganges and Brahmapútra. For the most part they are not very deep; their surface is very variable, and many of them are entirely dry during the hot season. *Tanks* are frequently met with; their numbers throughout the country testify the importance attached to them by the natives. Some of the tanks in Maissúr and the Karnátik are of surprising dimensions.

In the *Himálaya* also, there are but very few lakes, That of Nainitál, in Kămáon (6,520 ft.), the Vúllar lake, in Kashmír (5,126 ft.), and the Chinár lake, near Srinagger, at about the same height, suffice to exhaust the category of those deserving mention.

Glacier lakes—accumulations of water formed by one glacier obstructing the outlet of a higher one—are of much more frequent occurrence. At times, the wall of ice breaks away before the pressure of the swollen waters, when the lower lands become suddenly inundated, and the torrent rushes on with uninterrupted violence for miles, exercising a marked influence even down to the lower parts of the rivers.* Two of the most elevated glacier lakes are the Déo Tal, in Gărhvál (17,745 ft.), and the Námtso, or Yunám, in Lahol (15,570 ft.).

Western Tíbet and Turkistán possess many lakes, all of which are situated in great heights; they are however, gradually drying up, as becomes apparent by the unmistakable marks of larger surfaces remaining from former times. They contain a greater quantity of salt than lakes in general, and most of them to an amount which renders them more or less brackish. The water of some, however, is still drinkable; among these we particularly mention the Hánle and the Upper Tsomognalarí lakes.

LAKES OF WESTERN TIBET TURKISTAN.

Aksáe Chin..........	16,620 ft.	Níma Kar..........	15,100 ft.
Tso Gyagár..........	15,693 "	Hánle	14,600 "
Tso Kar, or Kháuri Taluá	15,684 "	Tso Gam...........	14,580 "
Múre Tso............	15,517 "	Tso Rul............	14,400 "
Kiúk Kiol...........	15,460 "	Tso Mitbál.........	14,167 "
Mansaráur, or Tso Mápan	15,250 "	Upper Tsomognalarí..	14,050 "
Ràkus Tal, or Tso Lánag	15,250 "	Lower Tsomognalarí..	14,010 "
Tsomoríri...........	15,130 "		

2. PASSES.

In *India*, the highest pass is the Sigur, in the Nílgiris (7,204 ft.). The Rangbódde pass, in Ceylon (6,589 ft.), is little inferior in height. Of the numerous passes (Ghāts) occurring in the West-

* Similar inundations, some of them of a most destructive character, have several times occurred in Tíbet. See "Vigne's Kashmír," vol. ii, p. 362, "Cunningham's Ladák," pp. 99, et seq., and "Capt. Montgomerie's Memorandum."

ern Ghâts, the Bapdéo and the Katrúj both exceeded 3,000 ft., the former being 3,499 ft., the latter 3,019 ft.

For *High Asia*, the mean of a sufficient number of such passes which lead over the three principal *crests* is particularly to be taken into consideration, it being approximatively proportional to the mean height of these crests. The passes situate in the lateral ramifications of the principal crests—though they are numerous—cannot be included in these general means, being geographically of subordinate importance.*

The mean height† of passes is as follows, the value being based on the heights contained in the table at p. 106.

a. For the Himalaya.................... 17,800 ft.

From Síkkim to Kishtvá; Bhután and Kashmír being excluded; the former for want of materials, and Kashmír on account of the Himálaya there losing the character of one well defined and predominant chain.

b. For the Karakorum.................... 18,700 ft.

We have data only from Long. E. Gr. 76° to 79½°, the heights in the eastern continuation being quite unknown.

c. For the Kuenluen .... 17,000 ft.

Here we know the height of two passes only. As they are situated, however, in parts not differing, in any important particular, from the general character of this chain, they may be looked upon as representatives of the others.

From these numbers it appears, that the Karakorúm has by far the greatest mean height of passes; but the one pass which we must still consider the highest is situated in the Himálaya. This is the *Ibi Gamin pass* (20,459 ft.), leading from Gărhvál to Gnári Khórsum, which we crossed August 22, 1855. It is known to the natives of Mána and Bádrinath, some of whom, about 36 years ago, once ventured to cross it with their laden sheep. The Mána pass at that time was infested by robbers, and the difficulties encountered, as also the loss of sheep and merchandize experienced on this occasion, were so considerable as to induce the natives to give up all idea of using the route as a commercial road.

Some comparisons with other and more familiar instances of elevation will tend to furnish a more adequate idea of the extraordinary height of this pass. The one coming nearest to Ibi Gámin in height, the Mustágh pass in Bálti, is 1,440 ft. lower. We may remark incidentally, that the Ibi Gámin pass is only 1,800 ft. below the highest point attained by us on the peak of the same name. This pass exceeds the highest in the Andes by

* We have had occasion to cross one pass of above 20,000 ft., one above 19,000 ft., six between 19,000 and 18,000 ft., nine between 18,000 and 17,000 ft., &c.

† The precise figures are: Himálaya 17,789 ft., Karakorúm 18,721 ft. and Kuenlúen 16,999 ft.

4,869 ft., Mont Blanc by 4,676 ft., and the highest pass in the Alps by 8,580 ft.

The *Mustágh pass* (19,019 ft.) and the *Ibi Gamin pass* (20,459 ft.) are, however, the only two as yet known above 19,000 ft. The third in height is the Changchénmo, (18,800 ft.), in the Karakorúm chain, but none of these, it should be borne in mind, are generally used, or crossed as commercial roads; they are evidently too high and too difficult of access. The highest pass as yet known to be regularly crossed with horses and sheep, for the purposes of commerce, is the Hárang pass, in Spíti (18,500 ft.); and between this height and 18,000 ft. are situated several of the most important and frequented passes, as the Mána (18,406 ft.), the Karakorúm (18,345 ft.), and the Kióbrang (18,313 ft.). Over none of these, or other high passes, however does anything lead at all approaching to the European idea of a road. Though below the glacier region a kind of foot-path is certainly discernible—very often a row of small stripes running parallel to each other—yet as soon as a glacier is ascended, or one of its ancient or present moraines, all such traces at once disappear. The general direction to be taken is indicated by stones, not unlike glacier tables, which the natives place along the line of route as way-marks; though in many parts, as on the Turkistáni road, north of Ladák, the uncertainty about the path to be followed is often removed by the appearance of the numerous skeletons of beasts of burden which distinguish the tracks of former caravans.

The Himálayan passes above 16,000 ft. are invariably closed by snow during the winter months between November* and May; even in the beginning of June, it is extremely difficult to cross a pass above 17,000 ft.

In the Karakorúm, the snow line is so elevated, and the absolute quantity of snow falling so small, even in winter, that the passes are never entirely closed. The Karakorúm can thus always be crossed even with horses, and the caravan road from Ladák to Turkistán accordingly remains passable throughout the year, though during the cold season, in order to avoid the Sássar pass, one of the most difficult parts of this route even in summer—the merchants prefer going up to the Karakorúm along the Shayók river.

In the Kuenlúen, all passes above 15,000 ft. are, as we heard, closed in winter by the heavy snow-fall.

In the *Andes*, the general mean elevation of the passes is, according to Berghaus:†

* In December, 1845, when the Chinese fought a battle near Tírthapúri, in Gnári Khórsum, the garrison of Tákla Khar fled across the pass near the head of the Káli river. Even in this unopposed flight, one half of the men were killed by frost, and many of the remainder lost their fingers and toes. See "Cunningham's Ladák," 1854, p. 353.

† Berghaus: "Zeitschrift fur Erdkunde," vol. ix, pp. 322–6.

For the Western Andes .... 14,500 ft.
For the Eastern Andes .... 13,500 "

The highest passes are: Alto de Toledo (15,590 ft.),* Lagunillas (15,590 ft.), and Assuay (15,526 ft.).†

In the *Alps*, we adopted as the mean for the passes 7,550 ft.

As the highest pass, at least in former times, not unfrequently used for commercial purposes, we may refer to the St. Théodule pass (11,001 ft.).‡ There are, however, besides *indentations* (*Scharten*) practicable for travellers, which are considerably higher,—exceeding 12,000 ft. Among others is the Old Weissthor, which we found to be 11,871 ft.;‡ another pass, the passage to Saas, recently called the New Weissthor, is marked on our map of Monte Rosa with the height of 12,136 ft. The height of the Col du Géant in the Mont Blanc group is 11,197 ft.‡

TABLE OF THE PRINCIPAL PASSES.

A. *In India.*

1. Dékhan. / 2. Málva.

Name.	Feet.	Name.	Feet.	Name.	Feet.
Bapdéo	3,499	Pochâma	2,446	Péndera	3,498
Katrúj	3,019	Nána	2,429	Silva	1,928
Par	2,698	Jām	2,328	Mándla	1,626
Nagchérri	2,645	Málsej	2,062	Póppera	1,560
Návi	2,617	Tal	1,912	Gúmba	1,553
Sápi	2,478	Bhōr	1,798	Singrámpur	1,437

3. Karnátik, Nílgiris, and Ceylon.

Sígur	7,204	Rangbódde	6,589	Gantvarpílli	2,373
Sispára	6,742	Kodúr	2,401	Kistnaghérri	2,150

B. *In the crest of the Himálaya.*

From Síkkim to Kíshtvaár.

Ibi Gamin	20,459	Umási	18,123	Kiúngar	17,331
Dónkia	18,488	Lángpia	17,750	Níti	16,814
Jánti	18,529	Máyang	17,700	Vallanchún	16,756
Párang	18,506	Lípu	17,670	Púling	16,726
Mána	18,400	Uta Dhúra	17,627	Shínku La	16,684
Nélong	18,312	Birmkánta	17,615	Bára Lácha	16,186
Kióbrang	18,313				

C. *In the crest of the Karakorúm.*

From long. E. Gr. 76° to 79° 30′.

Mustágh	19,019	Changchénmo	18,800	Karakorúm	18,345

D. *In the crest of the Kuenlúen.*

From long. E. Gr. 78° to 80°

Elchi	17,379	Yurungkásh	16,620

* Pentland's Map: "La Laguna de Titicaca and the valleys of Yucay, Collao, and Desaguadero," London, 1840.
† Humboldt's "Ansichten der Natur," vol. i, p. 123.
‡ Hermann and Adolphe: "Phys. Geogr. d. Alpen," vol. ii, pp. 30 and 32.

E. *In the Andes.*

Alto de Toledo...	15,590	Langunillas......	15,590	Assuay.........	15,526

F. *In the Alps.*

St. Théodule.....	11,001	New Weissthor...	12,136	Old Weissthor....	11,871

3. PEAKS.*

In *India*, the highest peak, Dodabétta (8,640 ft.),† is situated in the Nílgiris, in Southern India.

Of the peaks in the central parts of Ceylon, the Péduru tálla gálle reaches about the same height, rising up to 8,305 ft.; the well known Samanála, or Sripáda (Adam's Peak), attaining 7,385 ft.

In the mountain chains of Central India, in the *Vindhya* and *Aravállí* ranges, the peaks are considerably lower (Abu, 3,850 ft., Rajmirgárh, 3,753 ft.).

The Kalsubái, the highest peak of the Dékhan, attains only 5,410 ft.

High Asia. In the beginning of this century the Andes were supposed to contain the highest peaks on our globe, and Chimborazo to rise supreme above the rest. Though, as early as 1816, this was proved by Captain Webb's measurements, to be incorrect, yet some time elapsed before the superiority of the Himálaya above the Andes was generally admitted. At present (Nov. 1861) the number of peaks on the ranges of High Asia that are known to exceed the highest summit of the Andes, is remarkably great, amounting to forty-five.

In the *Himálaya*,† Gaurisánkar, or Mount Everest (29,002 ft.), is the highest peak in the world yet discovered; it is 6,000 ft. higher than the dominating peak of the Andes, and 13,220 ft. above the most elevated parts of the Alps.

In the *Karakorúm*, peaks have lately been discovered which are scarcely inferior in height to the loftiest in the Himálaya, though only its western part has as yet been explored. With regard to the heights of its eastern continuation, there is not enough known to allow even of an estimate being made.

The highest peaks of the Karakorúm are the Dápsang (28,278 ft.), the Diámer (26,629 ft.) and the Masheribrúm (25,626 ft.).

With reference to the *Kuenlúen*, we can only mention the peaks that we saw between the Yurungkásh pass and the western termination of this chain; our idea about the general height is the more limited, as we have not even itinerary reports of former travellers to assist us. None of the peaks seen there by ourselves exceed 22,000 ft.

* We here exclude, as not properly belonging to the regions to be compared, the countries northeast of Assám, with the Gri peak (15,300 ft.), and the Sóliman range to the west of the Indus, of which the highest peak, the Sufed Koh, rises to 14,839 ft.

† Notwithstanding their great elevation, none of the peaks of the Himálaya are visible from the sea, in consequence of their continental position.

Our volume contains the geographical co-ordinates (latitude, longitude, and height) of 132 peaks belonging to these three mountain ranges, which exceed 20,000 ft. in height, while one of them actually reaches 29,000 ft. (Gaurisánkar, or Mount Everest), and two range between 29,000 and 28,000 ft. (Dápsang and Kanchinjínga).

The relative numbers of the others are:

Relative Numbers.	From	To	Relative Numbers.	From	To
2	28,000 ft.	27,000 ft.	14	24,000 ft.	23,000 ft.
6	27,000 "	26,000 "	26	23,000 "	22,000 "
10	26,000 "	25,000 "	23	22,000 "	21,000 "
10	25,000 "	24,000 "	38	21,000 "	20,000 "

In the *Andes*, important alterations have recently been made with reference to the succession of peaks when arranged according to height, and even now the same amount of accuracy cannot be ascribed to the hypsometrical determination of its principal peaks* as to the trigonometrical operations in the Himálaya. The highest peak in the Andes is the Aconcagua (23,004 ft.); and there are as many as five peaks higher than the Chimborazo (21,422 ft.).

In the *Alps*, Mont Blanc (15,784 ft.) and Monte Rosa (15,223 ft.) are well known to be the highest peaks. In the tables of comparison, we have added a list of peaks above 14,000 ft., but have given the highest summit only in every group, in order not to extend the space unnecessarily.

TABLE OF THE PRINCIPAL PEAKS.

A. *In India.*

1. Nílgiris.

Name.	Feet	Name.	Feet.
Doddabétta	8,640	Kundamóya	7,816
Bevoibétta	8,488	Tamberbétta	7,292
Makúrti	8,402	Kokalbétta	7,267
Daversolabètta	8,380	Urbétta	6,915
Kúnda	8,353	Daverbétta	6,571

2. Ceylon.

Name.	Feet.
Péduru tálla gálle	8,305
Kirigalpótta	7,810
Totapélla	7,720
Samanála, or Adam's Peak	7,385
Namúna Kúli	6,760

3. Central India.

Parisnáth	4,469
Abu	3,850
Rajmirgárh	3,753
Búlbul	3,354

4. Dékhan.

Kalsnbái	5,410	Pútta	4,569
Dhórup	4,745	Ikhára	4,482
Varáda	4,655	Aunda	4,339
Tórna	4,619	Mándvi	4,123

B. *In the Himálaya.*

Gaurisánkar	29,002	Yássa	26,680	Nánda Dévi	25,749
Kanchinjínga	28,156	Jibjíbia	26,306	Ibi Gamin	25,550
Síhsbur	27,799	Barathór	26,069	Naráyani	25,458
Dhavalagíri	26,826	Yángma	26,000	Jánnu	25,304

* Humboldt's urgent wish to see these heights re-determined has not yet been realized. See his "Kleinere Schriften," p. 158.

C. *In the Karakorúm.*

Dápsang	28,278	Díamer	26,629	Masheribrúm	25,626

D. *In the Kuenlúen.*

The peaks seem not to exceed 22,000 ft.

E. *In the Andes.*

Authorities: H=Humboldt; *K*=Kellet and Wood; *P*=Pentland.

Aconcagua	23,004 *K*	Gualateiri	21,960 *P*	Sorata or Ancohuma	21,286 *P*
Sahama	22,350 *P*	Pomarape	21,700 *P*	Illimani	21,145 *P*
Parinacota	22,030 *P*	Chimborazo	21,422 *H*		

F. *In the Alps.*

Mont Blanc	15,784	Weisshorn	14,813	Grand Combin*	14,134
Monte Rosa	15,223	Mont Cervin*	14,787	Strahlhorn	14,100 ?
Täschhorn, or Lagerhorn	14,954	Dent Blanche*	14,305	Finsteraarhorn	14,039

Art. XIII.—*On the Detection of Picrotoxine*; by John W. Langley, S.B.

The seeds of the *Menispermum Cocculus*, known in commerce by the name of Cocculus Indicus, or popularly as "Fish berries," contain several active organic bodies. One of these, picrotoxine, is eminently poisonous and, it has been asserted, possesses in small doses a distinctly intoxicating quality. From this cause, and because the addition of the berries to the fermenting mash enables the brewer to dispense with a large amount of the malt which he would otherwise use, they have been largely employed for the adulteration of ale and beer, so much so in fact that it was deemed necessary in England to pass a law prohibiting its use for this purpose. While the composition and properties of picrotoxine have been long known, no process has been hitherto discovered by which it may be detected with certainty and confidence, the only method now employed being the recognition of its crystals under the microscope.

When picrotoxine obtained by any of the methods usually given for its preparation is examined, it will be found to possess the appearance and many of the properties of the alkaloids with which it has been classed, but it differs from them in the essential particular of not combining with acids, but on the contrary, it manifests a decided affinity for bases and behaves in many respects like a weak acid. Again it differs from them in the fact that if a salt of an alkaloid is decomposed with potassa we can

* The heights are taken from p. 511 of "Peaks, Passes, and Glaciers," edited by J. Ball, London, 1859; the others, for which no modification is known to us since 1864, are from our "Phys. Geographie der Alpen."

remove the organic base by ether from an aqueous solution, while the same course pursued with picrotoxine would fail to remove any of it from the water, it being positively necessary that the solution should be neutral or acid to enable the ether to dissolve it.

Picrotoxine is soluble in one hundred and fifty parts of cold water, but if a small quantity of caustic alkali is present it will readily dissolve in six or eight times its volume. When this solution is gently heated it becomes yellow and on platinum foil at a temperature far below ignition assumes a brick-red color which is distinctive and quite unlike the shade produced by sugar under similar circumstances. Picrotoxine like sugar and many indifferent organic bodies, possesses the property of reducing certain metallic oxyds. "It changes bichromate of potass to a fine green color." (Gmelin.) "An alkaline solution of picrotoxine reduces sulphate of copper to the suboxyd. (Otto.) This property however is common to too many other substances to be at all distinctive. A far more reliable test is found in oxydation.

If dry picrotoxine and nitrate of potassa are rubbed together in a watch-glass and a drop of sulphuric acid is added, no perceptible change occurs, but if a strong solution of caustic soda or potassa is poured upon this a bright reddish-yellow color is communicated to the mixture which partially dissolves and causes the whole liquid to assume the same tint. In this way very minute traces of picrotoxine may be discovered, so small a quantity as $\frac{1}{5000}$ of a gramme, if pure, being detected with the greatest ease. When as small a quantity as this is used we see the color most distinctly by gently breaking the solid cake of sulphate of potassa which lies on the bottom of the dish; portions of the precipitate will then appear of a crimson or purple hue.

In applying this test it is best to add about three or four times the quantity of nitrate of potash that we have of substance to be examined and to use no more sulphuric acid than is necessary to moisten the mass. The solution of potassa or soda should be made very strong and enough added to ensure considerable alkalinity in the mixture after the neutralization of the sulphuric acid.

Other powerful oxydizing agents will produce the same result but not with equal facility; chlorine passed over the moistened crystals, slowly dissolves them, and if we pour the alkaline solution upon them we obtain the same color, or we may substitute chlorate of potassa for the nitrate, the objection to the use of this however will be found in its tendency to explode when coming in contact with the acid.

This color, however produced, is not permanent but will slowly disappear with a rapidity proportioned to the amount of substance taken, but it will always appear with great distinctness when first adding the alkaline solution if any picrotoxine is present.

It is extremely probable that this color is produced from a trace of some nitrogenous body which pertinaciously adheres to the picrotoxine, as, on analysis, traces of nitrogen can be detected; but this body powerfully resists all attempts at separation, for when repeatedly crystallized the picrotoxine still retains a minute portion of it. It can be obtained perfectly free from nitrogen only by dissolving it in potassa and precipitating it by acids. When thus prepared its properties are the same as before with the exception of the purple color produced by oxydation and subsequent treatment with alkalies.

There is no substance at present known to the writer which gives this shade of color under these circumstances. There are two however which communicate a brownish-yellow to the fluid, and would, if present as an impurity, interfere with the distinctness of the reaction, these are sugar and strychnia; from the first we need suffer no inconvenience as it is perfectly separated in the ordinary method used for isolating the alkaloids; from the latter, picrotoxine is most completely removed by treating an acidulated aqueous solution of the two bodies with ether, the strychnia remaining as a salt dissolved in the water and the ether containing all, or nearly all, of the picrotoxine. To prove this the following experiment was tried. A quart of ordinary ale was divided into equal portions; into one ·045 gram. of picrotoxine and a little strychnia were introduced, the other was unadulterated; both were acidulated with hydrochloric acid, and agitated with ether; the ethereal solutions on evaporation yielded, in the first case, small microscopic crystals of picrotoxine mixed with a little extractive matter perfectly free from strychnine; the other yielded extractive matter alone. The test of sulphuric acid and nitrate of potash was then applied; the brownish-red color was produced in the first case, in the second there was no change. To ascertain the readiness with which minute quantities of picrotoxine can be detected $\frac{1}{50}$ of a gramme of it was dissolved in a pint of ale; this was acidulated and treated as above; the ethereal extract furnished ample proof of the poison when tested.

In another experiment the stomach of a cat which had been poisoned was emptied of its contents so that only the picrotoxine absorbed by the coats of the stomach might be extracted. It was treated with alcohol and the solution evaporated to dryness. Acidulated water being poured on the residue, the picrotoxine and a little organic matter were dissolved; being now treated with ether and the solution evaporated, small crystals of picrotoxine were obtained, which, when tested, produced the characteristic red color. A portion of animal matter free from poison treated in the same way gave no discoloration.

In examining a liquid for picrotoxine it should first be rendered acid then shaken with ether; the residue left on evaporation of the ether examined with the microscope for small prismatic crystals; if a few drops of sulphuric acid diluted with its volume of water are added in the cold and there are alkaloids present, they will dissolve, only so much picrotoxine passing into solution as is due to the water present, about one part for one hundred and fifty of water. A few drops of an alkaline fluid will dissolve the crystals and on applying heat the fluid will become first yellow and when more strongly heated will become brick-red. A small portion ground in a watch-glass with nitrate of potassa and sulphuric acid gives a solution which when rendered alkaline by potash or soda becomes a bright-red.

University of Michigan, Ann Arbor, March 26th, 1862.

ART. XIV.—*Some contributions to a knowledge of the constitution of the Copper Range of Lake Superior;* by C. P. WILLIAMS, A.M. and J. F. BLANDY, M. and C.E.

THE enterprise and vigor with which the *exploitations* of the Portage Lake District of the Copper region of Lake Superior have been carried on within the last few years, have developed many facts of great interest and importance in the constitution and structure of the Trap range of that place, beyond what have been made public through the medium of the excellent work, "The Metallic Wealth of the U. S.," by J. D. Whitney, Esq., and the reports of the geologists having in charge the examinations of the Lake Superior mineral districts.

The Trap range at Portage Lake has a width, as far as known, of about three miles, and is made up of a series of compact, granular, amygdaloidal traps, with occasional intercalations of sandstones and conglomerates, the whole having a strike of N. 32° E. and S. 32° W., with a dip of from 16° to 75° N.W.—the highest angle of dip being near the southeastern boundary of the range, while towards the northwestern limit, the rocks become more and more horizontal, until, finally, the sandstone which succeeds it becomes absolutely so.

Coincident, both in course and dip, with the rocks of the range are the so-called lodes of the district, which present no features of fissure veins, but are simply beds of highly amygdaloidal trap, carrying throughout their whole width—from 6 to 40 feet—small masses and grains of native copper, with a small amount of native silver, the cavities of the rock being large and filled with calcareous spar, quartz, chlorite, and several minerals of the zeolite family.

Several of the intercalated beds of sandstone and conglomerate also contain minute particles of copper, but none of these as yet opened have shown an amount of this metal sufficient to warrant exploitation. However, on account of the very great extent linearly to which these beds are developed over the country, their persistence in thickness, and their well marked and constant characters, they become a valuable guide in explorations, and a convenient reference in the location of the various metalliferous deposits.

On a closer examination of the trappean range at Portage Lake it would appear to be divisible into certain zones, the rocks of which are bounded by the conglomerate and sandstone belts, and present features which characterize and separate them from the members of the other series. More especially is this observable in the copper-bearing amygdaloidal beds. The cupreous deposits of the several series differ so greatly in mineralogical composition that no difficulty exists in referring the materials from any one of them to its source, they being almost as well characterized as the vein-matter of the different districts of this mining region.

A complete section of the range at this point has not yet been obtained, as the explorations have not been extended to the extreme east and west boundaries of the trappean rocks. For a width of about two miles all the belts have been exposed, and the examinations have developed four distinct zones of rocks, which we shall name from the main metalliferous deposit in each. Passing from the east to the west these are: the Isle Royale, Pewabic, Hancock and the South Side series, or, as they are locally styled, formations.

Isle Royale Zone.—The rocks we shall include in this zone cover a width of about one and one half miles, and are limited on each side by belts of conglomerate. Within this distance, fourteen copper-bearing deposits have been opened at various times, all showing analogous features, though but two have as yet been systematically laid open to any great extent. They all have a very large amount of epidote, massive as well as crystalline, entering into their composition, and a comparative paucity of crystallized carbonate of lime. The other minerals in the constitution of the so-called lodes of this series, and usually denominated the vein-stones, are more crystalline in structure than the same species found in the other zones, but the abundance of the epidote it contains, and the almost total absence of this mineral in the neighboring zones, must be regarded as the main distinction. Another point of importance in its economical bearings, is the character of the copper produced from the mines in this zone, the proportion of the heavier description of copper being greater in this than in the other series.

Thus the Isle Royale lode yields in the following proportion: of mass and barrel (heavy) copper 60 per cent, stamp (fine) copper 40 per cent, whilst the great metalliferous deposit of the second series produces of mass and barrel copper 43 per cent, and of stamp copper 56 per cent. This comparison has been found to hold good through a series of years. All the intercalations of conglomerate opened in this zone, from its western to its eastern boundary, are cupriferous, and most of them have overlying them contact deposits of good width in which this metal has been concentrated, while not one bed of the sedimentary rocks found west of the conglomerate forming the western boundary of the zone, has been found to contain a trace of cupreous mineral.

Near the eastern limit of this zone several of the lodes have been found to contain a small amount of the sulphuretted ores, and a large amount of quartzose vein matter with arsenids of copper (whitneyite and domeykite) has been found in angular fragments on the surface in the same vicinity, pointing to the proximity of veins of an age and composition different to anything yet opened in the Portage Lake District, and most probable synchronous in formation and repletion with the veins mined in the Southern or Bohemian range of Point Keweenaw.

Pewabic Zone.—Resting on the rocks of the first named series, but separated from them by a copper-bearing conglomerate with its accompanying contact vein, and occupying a width of nearly 1300 feet, occurs the Pewabic zone. In this formation ten belts of metal-bearing amygdaloid have been opened, of which three only have been worked to any extent, and one of these, that from which the series has been named, has given wonderful results, having yielded about 600 lbs. of ingot copper to the cubic fathom. The rocks are characterized by the almost total absence of epidote, whilst those beds carrying copper have a large amount of calcareous spar and laumontite entering into their composition. No conglomerate intercalations occur in the space occupied by these rocks, though it is limited on the west by a belt of such rock of 40 feet thickness, which, though opened at several points, has shown no trace of copper. The character of the copper produced from the amygdaloid belts mined in this series has been alluded to in the description of the rocks of the Isle Royale zone. No traces of any sulphuretted or other ores of copper have been found in this series.

Hancock Zone.—The rocks comprised within this zone have a width of nearly 600 feet, being included between the western conglomerate of the Pewabic zone, upon which they rest, and another bed of the same rock of a width of about 45 feet. The rocks dip at an angle of nearly 45°, and are of a much softer character than anything noticed to the east of them, chlorite entering largely into the composition, and the entire formation is much broken up and fissured by cross-courses at the places opened.

The metalliferous occurrences yet opened comprise three belts of amygdaloid trap, containing much chlorite, and about two per cent, or upwards of 600 lbs. of ingot copper to the cubic fathom. The conglomerate limiting the series on the west contains no copper.

South Side Zone.—We have given this name to the rocks resting on the Hancock formation from the fact that their characters have been almost entirely developed by the explorations on the lands of the South Side Mining Company. These rocks comprise a width of over 2100 feet, and are made up of frequent alternations of porous and highly amygdaloidal traps, with belts of sandstone and conglomerates, for a distance of nearly 1000 feet, the balance being almost entirely sandstone and conglomerate, with an occasional intercalation of a porous trap bed. This zone appears to be almost entirely destitute of metalliferous occurrences. Beyond its limits the few explorations made show the rocks to be entirely sandstone, with a constantly decreasing angle of dip, as the igneous rocks are receeded from, till at a distance of two miles it is found in horizontal layers.

The base of the range, as developed at the southeast limit at Portage Lake, is a fissile chlorite rock, the same as forms the basis of the Bohemian or Sulphuret Range at Point Keweenaw. This has elevated the bed of trap which rests on it to the northwest, and the sandstone which lays on it to the southeast, to a considerable angle, amounting, in the case of the trappean rocks, to 75°, but which we have shown becomes gradually less in the northwestern development of these rocks. The decrease in the angle of dip of the sandstone at the southeast is much more rapid than that of the trappean rocks and sandstones, and at a distance of three quarters of a mile from this line of elevation is found again in a horizontal position.

The occurrence of this chlorite rock in proximity to those beds of rock which form the base of the Isle Royale series, and contain sulphids and arsenids of copper, would appear to point to the identity of the rocks of this zone with those forming the southern limit of the greenstone or north range, and the northern boundary of the southern or Bohemian range of Keweenaw Point. This view is further strengthened by some examinations recently made by Samuel W. Hill, Esq., in that region where that gentleman found an extensive series of trappean beds, highly epidotic in composition, and carrying native copper, intercalated with other beds containing the ores of that metal. There are doubtless many rocks occurring in the Bohemian Range, in the vicinity of Lac la Belle, porphyritic in character, which are not developed in the Portage Lake District, but this does not affect the question of the identity of the rocks of the eastern portion of the Isle Royale series with some of those known to occur in the Sulphuret range, since instances of the thining out of belts of trap have been observed and well proven by explorations at Portage Lake, as well as elsewhere. The Isle Royale series of rocks widens out northeasterly from Portage Lake towards Point Keweenaw. The Pewabic series widens out towards the northeast, and thins out southwesterly at the rate of over sixty feet to the mile; and the Hancock zone also becomes wider towards Point Keweenaw, but the rate of increase is much less than in the case of the Pewabic rocks—amounting to but about fifteen feet in the mile.

In the Keweenaw Point District it has been shown by recent researches that the series of rocks in which the Cliff vein has been found most highly productive, recedes from the greenstone in its easterly prolongation, other belts of compact and amygdaloid traps being introduced between the crystalline belt and that series, the rate of increase being in all probability much greater than anything noticed above.

Towards the Ontonagon District the trap range again widens out, and at its southern boundary we find a series of ridges made up of rocks analogous in structure and identical in mineralogical composition with the belts found making up the Isle Royale zone. The mineral accumulations here are also in the form of segregated deposits, called "epidote lodes"—that mineral entering largely into their composition. The so-called veinstone is of such appearance as to be readily confounded, even by the experienced eye, with matter from the Isle Royale lode at Portage Lake.

Traces of the sulphids of copper have been found in this region also, on the southern limit of the United States location, as well as elsewhere. The course of these rocks is through the Evergreen Bluff, Peninsula, Forest, United States and Ohio Trap Rock locations.

Thus, from the end of Point Keweenaw to a very considerable distance beyond Portage Lake the rocks which we have classified as belonging to the Isle Royale series, appear to exist at or near the base of the Trap Range of Lake Superior, but in the western prolongation of the Range, towards the Wisconsin boundary line, another series becomes developed, as is shown by the works at the Norwich mine, but little is known of the relation or composition of these rocks. However, a bed of fissile chlorite rock which we have reason to suppose is identical with the rock we have described at the base of the range at Portage Lake, has been opened at the southern limit of this series of rocks, and is shown at the mouth of the adit of the Windsor mine.

From the above it is obvious that though many of the belts of rock of the Range are persistent throughout its whole length, yet the absolute contact of all the zones we have pointed out should not be too rigidly expected over the whole distance, since other belts or series of belts may be introduced between them.

Veins of the Lake Superior Region.—Three classes of metalliferous occurrences have been shown to exist in the Trap Range: Fissure veins, Segregated and Compact deposits.

Fissure Veins.—This class of veins are almost entirely developed on Point Keweenaw. In their course they may be traced across the whole width of the mineral formation, from the Bohemian or South Range to the north shore of the Point, cutting the sedimentary beds without a deviation of course, and even breaking through the pebbles of the conglomerate. They generally show small displacements of the beds, both horizontally and vertically, although there are some marked exceptional examples. The largest '*heave*' yet noticed is that at the Humboldt mine, near Eagle River, where the "Ash bed"* is found on the east side of the fissure vein, about 350 feet north of its position on the west side.

The course of these veins varies from N. 16° E. to N. 58° W., the average of the seventeen principal ones now worked being N. 18° W. They are nearly perpendicular, with a slight underlay to the east.

Evidences of the existence of a later and distinct line of fracture are to be found, the course of which was E. of N. about 15°, and which has given rise to some powerful, though not highly productive veins, which displace considerably the formation as well as the veins of the first class. At the North American mine the Cliff vein is *heaved* 250 to 300 feet by the Armstrong vein, which is necessarily posterior in formation. The existence on Keweenaw Point of still another line of fracture, with a general course of N. 65° E. has been contended for by some, but the evidences are more from the topographical features than from any direct explorations or exploitations. Certain it is, however, that one member of this system has been opened in the Portage Lake District, but presented no features to warrant any further examination, so that nothing is known of its composition and structure. Still another has been traced for a length of 1200 feet on the Columbian location. In the same district a vein belonging to the second system was mined for some time on the Quincy property, but did not prove of remarkable richness.

* A segregated deposit situated north of the greenstone axis of Point Keweenaw, and yielding 1·2 per cent ingot copper. It has been extensively mined at the Copper Falls, Phœnix and Garden City locations, and has been traced for 12 miles over the country.

In the Ontonagon region but few fissure veins have been opened, and most of these have a course of from 60° to 70° east of north, varying about 30° from the bearing of the formation, with a dip of from 50° to 60° to the north. An exceptional instance is found in the one vein opened on the Douglass Houghton property, which was transverse to the line of bedding of the trap, and is necessarily of different origin.

On account of the variation of the meridional course, as well as the direction in comparison with the bearing of the beds of rock, it is difficult properly to classify the fissure veins of the different districts. An examination of them in connection with the topographical features of the country would seem to point to various causes of occurrence, arising from the method of elevation of the trappean range. The curvature of the range on Keweenaw Point around the centre of elevation of the South or Bohemian Range, would appear to account for the *radial* fractures, embracing nearly all the veins of the first class, the course of the veins changing from E. of N. at the east end of the Point, to N. 58° W., at the North American Mine, at the west end of the curvature. Variations from the general rule of radial fracture occur, but it is a question whether these cannot be accounted for by local causes, or whether they are not fractures between the main veins.

From the North American Mine to a few miles southwest of Portage Lake the Range holds a very direct course, showing no conspicuous elevations, and the topography of the country denotes no disturbances in the formation with the exception of the deep gorge of Portage Lake. In this section no fissure veins of the first class have yet been found.

The fissure veins of the first class in the Ontonagon District seem to be due to the warped position in which the elevating forces have left the strata. The range is broken by many deep gorges, marked by the passage of the rivers. The best example we have of the warped position is in the division of the range between the Flint Steel, and the Ontonagon Rivers, the dip of the rocks at the east end or in the Flint Steel mine being 33° and gradually rising to about 57° at the National mine near the west end. The small number of fissure veins which have been opened in this district, and the limited extent of the workings upon them will hardly justify any positive assumption with regard to their origin; we would however instance the North vein of the Minnesota mine as being probably an excellent example, and one which may be found repeated in other sections of the same district. The course of this vein is 60° E. of N. cutting the strike of the strata at its intersection with the conglomerate bed at a small angle, the angle of intersection being open towards the east. Direct experiments with plastic substances in layers raised in a position to form a warped surface, similar to the one referred to, have been made to show that fractures would be formed in exactly the same manner as those existing at this locality. In the process of elevation it would be natural to suppose that the greatest amount of lateral motion would take place along the surfaces of the sedimentary beds, for the reason of their lesser adhesion, and besides that they present a comparatively smooth surface, whereas the surfaces of the trap beds are rough and irregular as shown in the amygaloidal beds, which have been mined. It is also to be supposed that the length of these veins will be found comparatively short, and would show a displacement at the intersection of other sedimentary beds.

The veins of the second and third class are mostly known in the Portage Lake District. These may be due to a second elevation of the mineral range, evidences of which, we see in the position of the terrraces on the shores of Portage Lake. These on the north side of the lake are higher above the present surface of the water than on the south side, besides which, instead of being horizontal, present a very decided ascent towards the east. On the south shore this ascent is very perceptible and also the change in grade, which takes place on the Sheldon location; from that point it being steeper towards the east than the descent towards the west.

The large veins of the third class, having a course of 60° to 70° E. of it—known in the mines as cross courses,—are most probably the effects of the force causing the depression of the range forming the deep gorge of Portage Lake. This view is well supported by the results obtained in exploring at the Dacotah location on the south side of the Lake for the Pewabic lode, the openings on which have been entirely confined to the north shore. On running its course and making calculations for the differences in level,—on account of the dip of the lode,—between the two shores the lode was found to be at a point 1300 feet east of the continuation of its direct course as pointed out by the surveyor, the distance between the two points being about one half a mile and nearly the whole being occupied by the gorge of Portage Lake. No prominent veins of this class have been found in this district, except on the hill sides bounding the Lake. Veins of the same class may yet be discovered at a greater distance from the lake although not necessarily parallel with the ones now found.

Segregated Veins.—The class of segregated veins has, within the past five or six years, attracted the most attention from the mining companies on account of the facilities they offer for economical mining. They are as before stated simply beds of cupriferous amygdaloid coincident in strike and dip with the literature and science. He was very kindly disposed towards young men, especially to those physicists and chemists who labored in his own favorite studies. For such as these he ventured all, and zealously protected them. It is well known how much abuse this kindness called forth, so that some physicists and chemists who had a sense of their own dignity, for a long time refrained from publishing their researches upon rotary polarization applied to the detection of chemical substances, for fear of being regarded as devoted to the science only for the purpose of securing the favor and patronage of a powerful man. Such cases were not, however, very numerous; far greater was the number of these professions whom Biot patronized and who justly deserved this favor, of whom the illustrious acoustician, Savart, may serve as an example. We have previously noticed (this Jour. [2], xvii, p. 294) his benevolence to the chemist Laurent.*

Isidore Geoffroy St. Hilaire: The founder of the "*Société Zoologique d'Acclimatation,*" &c.—The eminent Zoologist who has rendered such great service to science died on the morning of the 10th of November last. He was the son of Etienne Geoffroy St. Hilaire. Among his ancestors were two chemists known in history as the two Geoffroys who made their mark upon the science of their age. The example and instruction of his father early inspired Isidore Geoffroy St. Hilaire with a taste for the natural sciences, to the study of which he devoted himself with an ardor which was crowned with precocious success. He was born in 1805 and in 1826 he presented to the Academy of Sciences a memoir upon mammifers. He was only twenty-seven when he was elected to the place vacated by Latrielle as member of the Academy of Sciences of which his father Etienne Geoffroy was president. Some time later he was appointed Professor of Zoology in the Faculty of Science at Bordeaux, afterwards he became Professor of Zoology at the Museum, Director of the Menagerie which had been established by his father, and at length Professor of Zoology in the Faculty of Sciences at Paris. Doubtless he was much indebted to the patronage and reputation of his father, yet he made great and successful efforts to sustain the honor of his name and to justify his rapid advancement as an instructor in the University. As a zoologist he devoted himself first of all to extending and developing the great ideas put forth by his father. He was also engaged in making practical applications of zoology by multiplying the species of animals useful to man for food, clothing, and labor. It was this purpose which led him to found the "*Société Zoologique d'Acclimatation*" which has already proved so useful and which extends its influence not only in France but throughout Europe and even to all parts of the world as has been often mentioned in my former correspondence.

In 1836 he delivered at the Museum, a course of "*Leçons de Tératologie,*" which were reported and published in one volume octavo by Victor Meunier, a young man of great promise whom Etienne Geoffroy had taken into close friendship. The same year he delivered a course of "*Leçons de Mammologie,*" which were reported by Paul Gervais. His "*Leçons de Zoologie Générale*" were published in 1848. He also pub-

* We have received an advance copy of an able and discriminating notice of Biot, from the learned Secretary of the American Academy of Sciences at Boston, for which we have not space in this number.—Eds.

lished from 1832 to 1836 "*Traité de Tératologie,*" 3 vols. in 8vo, with plates—"*Essai de Zoologie Générale* ou *Mémoires sur le Zoologie Générale l'Anthropologie et l'Histoire de la Science,* in 8vo. 1840."—"*Historie Naturelle des Insects et des Mollusques,*" 1841. 2 vols. 12mo, with figures.—"*Vie, Travaux, et Doctrine Scientifique, d'Etienne Geoffroy St. Hilaire,*" 1847, in 8vo.—"*Catalogue Méthodique du Museum d'Histoire Naturelle,*" 1851, in 8vo.—"*Domestication et Naturalization des Animaux Utiles,*" 1854.—"*Histoire Naturelle Générale des Règnes Organique, Principalement chez l'Homme.*" 1854–1857. 5 vols. in 8vo. Besides these works there are many memoirs scattered through the *Comptes Rendus,* the *Annales des Sciences Naturelles,* the *Bulletin de la Société Zoologique d'Acclimatation,* &c.

From this it is easy to see that Isidore Geoffroy St. Hilaire deserves an honorable place in the annals of science, although his services are less appreciated because they have not equalled those of his father. But from what we have enumerated it is evident that he had sufficient knowledge, enterprise and zeal to make his way for himself. It was obvious to all who met him that fortune had loaded Isidore Geoffroy with favors without drying up his sympathies or rendering him egotistical. He sympathized with all sufferers and interested himself especially for those men of science whom fortune little favored nor did he wait for the rich or powerful to patronize them before he became interested for them.

In 1854 he was president of the Academy of Sciences, before which time he had no acquaintance with the chemist Laurent whom he knew only by reputation. It was sufficient for him to learn the precarious situation of the widow and children of the chemist to induce him to go at once to Madame Laurent and place at her disposal all the influence of his name and position as president of the Academy of Sciences. We can say of him as we said of Biot, that he was a member of the principal learned societies of the world.

Acclimation.—We cannot better conclude the obituary of Isidore Geoffroy St. Hilaire than by noticing the one great work of his life, the "*Société Zoologique d'Acclimatation,*" the success of which is becoming more and more remarkable, thanks on the one hand to its organization and on the other to the zeal and the talents of the men who composed it, and who, like Messrs. Richard (of Cantal)* and Guerin Meneville, devoted themselves to natural history from the love of it, having made great progress in such studies long before the establishment of the Society of Acclimatation.

Disease of Silkworms.—Coincident with the formation of this Society in 1854, was the appearance of a scourge which has several times threatened to destroy one of the great industries of France, the silk culture, which alone yields 300,000,000 francs per annum. The silk manufactured in France is not all produced in the country. The silkworm ordinarily produces about 150,000,000 francs of raw silk besides which we import about 60,000,000 francs value more. This silk after being manufactured at Lyons, Nismes, St. Etienne, &c., acquires a value of more than 310,000,000 of francs. The disease of the silkworm becomes therefore to these manufacturing centres a perfect scourge; hence from its very

* This Journal, [2], xxviii, p. 431.

origin the Society of Acclimation has undertaken to examine the cause of this disease among the silkworms. In this investigation the Society has been ably seconded by M. Guerin Méneville who had made these insects a special study. Not only have they made a thorough study of the *Muscardine* and other diseases of the silkworm, but they sought also to acclimate other silkworms, particularly the species which feeds upon other leaves than those of the mulberry. The following *résumé* of those experiments we find reported in the Bulletin of the Society. "From these researches it appears that the disease of the silkworm is caused principally by a disease of the mulberry trees, on the leaves of which the silkworm is fed. This disease can be cured by placing the infected eggs for some time in a box containing a little spirits of turpentine. But this treatment does not prevent the reappearance of the disease upon the worms when they are fed upon the leaves of diseased mulberry trees."

In reference to the introduction of new species of silkworms, we have mentioned in previous correspondence the *Bombyx cynthia*, a silkworm which feeds upon the *Ailanthus glandulosa*. More than two thousand amateurs are this year engaged in efforts to rear this worm which feeds freely upon the Ailanthus trees; these experiments have not all resulted satisfactorily, the insect-eating birds have made a war of extermination upon the *Bombyx cynthia*. Nevertheless the degree of success is so great that, according to M. Guérin, it is now practicable to carry on with some success experiments on a large scale.

But the principal difficulty connected with this manufacture arises from the difficulty of separating [reeling] the silk from cocoons of the *Bombyx cynthia*. This difficulty has at length been overcome by two different methods, one of which was discovered by Madame Vernède of Corneillan, the other by Dr. Forgemol.

The culture of the silkworm which feeds npon the Ricinus (Castor Oil Bean) ought to be abandoned in France on account of the climate. This industry flourishes only in warm countries where the Ricinus does not freeze in winter; after experiments tried upon an extended scale the culture of this silkworm has proved successful in the Canary Islands.

While experiments are continued upon a mixed breed between the silkworm of the Ricinus and that which feeds upon the Ailanthus, on the other hand, experiments are in progress with the silkworm which feeds upon the oak, also upon the *Bombyx hesperus* in an experiment at Cayenne where Michlez sought to introduce the culture of silk.

This Bombyx does not succeed in France because it hatches at a season of the year when all vegetation is arrested. The plant upon which this silkworm feeds in the natural state, bears the name of *café diable*. Michlez discovered that the Ailanthus suited it still better, and that it developed itself perfectly upon this tree. In a package of silkworm eggs sent to the Society of Acclimation by the French Consul in Japan, (M. Duchesne de Bellecourt) Guérin Méneville found a new kind of silkworm. This species, known in Japan under the name of *yama-maï*, feeds upon the oak. The silk which it produces is of a very beautiful quality. It is more solid and more beautiful than that of other species of silkworm which feed upon the oak.

Astronomy.—Reconstruction of the Bureau of Longitude.—For a long time there has existed among astronomers in Paris a strife quite unworthy of the science, in which personal rivalries are much more prominent than the progress of astronomy which has gained nothing by the unhappy scenes of which the Academy of Sciences has been for a long time the theatre, and which have been of no benefit even to those who have systematically undertaken to disparage all the scientific labors of the most able astronomer among them, the Director of the Observatory. The work of the Bureau of Longitude having suffered very much by these internal dissensions, this body has been reconstructed, retaining all who have heretofore been members, and adding some new names from among the contestants. The class of assistant members is suppressed and all the members are made equals. The Bureau as now constituted comprises

3 Members of the Academy of Sciences, viz:—Liouville, Le Verrier and Delaunay,

5 Astronomers, viz:—Messrs. Mathieu, Laugier, Yvon de Villarceau, Faye and Foucault.

3 Members from the Navy, viz:—Admirals Mathieu, Deloffre, and Nn. . .

1 Member belonging to the War Department, Maréshal Vaillant.

1 Geographer, Colonel Peytié, with the rank of Major.

3 Artists, Messrs. Bréguet, Lerebours and Brunner.

It has been organized by the appointment of, for President, Maréshal Vaillant; Vice-President, Admiral Deloffre; Secretary, Villarceau.

New Observatories.—The Observatory at Paris is about to establish a branch in the south of France, in order to have the advantage of a purer sky than that on the borders of the Seine. The necessity of this was more than ever realized in the recent efforts made to recognize the Satellite of Sirius lately discovered by Mr. Clark. It was only after repeated efforts and with a sky for a few moments unusally pure that M. Chacornac was able to verify the discovery of Mr. Clark. Since then clouds have rendered it impossible to see the companion of Sirius again at Paris.

Astronomers appear to be more than ever engaged in searching for a pure sky. M. Bulard, the Director of the Observatory of Algiers has found a sky of remarkable transparency in the oasis of Laghouat which is situated exactly in the meridian of Paris. They will not fail to found an observatory in that beautiful country when it becomes more accessible. Already Russia has taken a similar step by establishing an observatory on Mount Ararat.

International College.—For some time there has been a project considered which will be laid open for *concours* through the medium of the Universal Exposition of London. It relates to the establisment of an International College to be organized simultaneously at Paris, Oxford, Munich, and Rome or Florence.

The principal of this unique College is to establish in the four countries an identical course of study to be conducted simultaneously in four different languages so that the students may at any time change their residence and language without any modification of the method or course of study. The initiative of this measure has been taken by M. Barbier, a manufacturer of Clermont-ferrand. In order that this question may receive the consideration which it merits, M. Barbier has laid it open for *concours* accompanied with the sum of 5,000 francs. A commission chosen by the Jury of the Exposition of 1862 will give its advice upon the classification in the order of their merits of the memoirs which may be presented upon the subject by different competitors.

These memoirs written or translated into French are to be delivered before the 31st of May 1862 at Paris at the Palace of Industry, or at London at the hotel of the Imperial Commission. The authors of the four memoirs classed in the first rank will receive prizes of 2000, 1500, 1000, and 500 francs respectively.

This *concours* has created some sensation and it is hoped that it will be followed by useful results. It should be remembered that in 1855 the project of an international college engaged the attention of Fortoul the Minister of Public Instruction whose sudden death in 1856 delayed the progress of the enterprise. His attention had been directed to this subject by Eugène Rendu, the Inspector General of the University. A complete programme of studies was proposed for this project which has for a considerable time been executed though imperfectly in several countries. Thus there is at Paris an Egyptian school supported by the Viceroy of Egypt which receives only Egyptians, at Athens a French School supported by the French government where only young French literati are received, &c. Thus we see that the idea of Rendu and Barbier existed previously although only in the germ.

Manufacture of Aluminium.—We have repeatedly mentioned to our readers the progress of the manufacture of Aluminium since St. Claire Deville discovered the method of obtaining it on a commercial scale. They have learned to forge aluminium, to file, roll, punch and to engrave it with any design the workman may select. The method of drawing it into fine wire has remained hitherto an unsolved problem, though not for the want of diligent efforts to accomplish it. The superintendents of the two manufactories of aluminium ingots, comprehending the importance of being able to draw this metal into fine wire have made great sacrifices to resolve the problem. They have applied to the manufacturers of gold wire both at Paris and at Lyons, but all their efforts have failed. The aluminium has so little density that its texture is at once broken up and it becomes as friable as glass, so that it leaves upon the draw-plate the superficial molecules which are in contact with the instrument.

The problem of drawing aluminium into wire has however just been resolved by M. Garapon, an artisan of Paris who now conducts the operation in a truly workmanlike manner. He furnishes the aluminium wire at from 60 to 100 per cent cheaper than silver wire of the same length. The price of aluminium is always about 200 francs per kilogram. For the purpose of drawing it into wire they commence with rods of aluminium of one metre in length and 12 millemetres diameter, these the inventor easily reduces to wires of the size of a hair and many hundred kilometres in length. These products appear in the London Exposition, where are seen articles of lace work, such as epaulettes, embroideries, textile fabrics, entire head-dresses, with mounting and ornaments constructed entirely of aluminium. These articles are remarkable for their lightness, and they show that a novel manufacture has been created by the new process of drawing aluminium into very fine wire. For the details we must await the results of the London Exposition.

Culture of Cotton.—The planting of cotton in the differnt French and English colonies has made considerable progress; it would succeed still better in France if the French were accustomed to act for themselves, without the aid of the government. The culture of cotton in Algeria in the vicinity of Mortaganem has received a great impetus from the establishment of an English company in that country so favorable to the growth of cotton. Other experiments have been made in Senegal by both the French and the English. In India already a million kilograms of this textile material have been collected, and the present year the product will be doubled. At the present time an effort is in progress to take advantage of the favorable climate and soil of French Guyana to introduce the culture of cotton on a grand scale. This plant was cultivated there a long time since, but the culture having been badly managed it was for a time abandoned.

The question has arisen of reopening the culture in that region. Two reasons principally determine the resumption; first cotton succeeds there remarkably well and it is of excellent quality, secondly there are found there, what is wanting in other climates, plenty of laborers. Besides the small proprietors who live there, and who ask for nothing more than some lucrative culture, there is the penitentiary occupied by 10,000 or 12,000 convicts who are already accustomed to toil, and who have recently performed well the work of clearing the land.

On all sides then there is an effort to provide against the crisis which more and more menaces the manufacture of textile fabrics. With the cotton which Egypt already produces, and which she will be more and more interested to produce, especially in the vicinity of the Isthmus of Suez, with that which is obtained in India and Algeria, with the plantations which are made or increased in Senegal, Soudan and Cambodia, and lastly in Guyana, European industry hopes to free itself completely from the tribute which it has hitherto paid to the United States for cotton.

Scientific News.—We here place on record certain scientific facts of some importance which have recently transpired. Among these are (1) The discovery by M. Lamé of the existence of a thrid and non-luminous ray in double refracting media. (2) The production by Berthelot of the hydrocarbon C^2H, (acetyline) by synthesis, by making a current of hydrogen pass over charcoal rendered incandescent by the electric current. (3) The transformation of aldehyd into alcohol effected by Wurtz by means of amalgam of sodium. (4) The magnificent researches of Hofmann upon the derivatives of aniline, those beautiful colors which have for some years produced such a sensation in industry which no one has yet been able to obtain in a state of purity, and which Hoffmann has reduced to two types, rosaline and leucaniline, which bear to each other the same relation as white indigo and blue indigo. (5) The treatment and cure of obstinate ulcers by (solid) carbonic acid which is the most powerful cicatrizing agent known. (6) The construction of a telescope with a silver mirror of 80 centimetres ($=31\frac{1}{2}$ inches) diameter and with a focal length of 4·5 metres ($=17\frac{3}{4}$ feet) by Foucault. (7) A new system of railways called "*Chemin de Fer Glissant*" (sliding railways) by M. Girard. In this system there are neither wheels nor axles; the carriages are true sledges sliding upon hollow runners moving upon rails sufficiently large. The runners contain water under pressure, which is designed to raise them, and by seeking to escape from all parts to prevent all friction of metal upon metal. Girard makes his experiments at the expense of the Emperor of the French. This railway system moves upon a road 40 metres in length, and for one on this scale the results are already very satisfactory.

Bibliography.

The following works have been published by HACHETTE, *rue* Pierre Sarrazin, Paris:

J. Nicklès.—"*Relations d'Isomorphism qui Existent entre Les Métaux des Groupe de l'Azote,*" 1862. The fundamental conclusion of this work is that bismuth ought to be hereafter arranged in the nitrogen family with phosphorus, arsenic and antimony. The author shows this by new facts drawn from chemistry and crystallography. Thus the composition and the crystaline form of I^3As, I^3Sb, I^3Bi, also the combination that these iodids or the corresponding bromids give with alkaline chlorids, bromids or iodids; he describes a great number of new combinations, distributed in isomorphous groups; the more interesting are those containing at once both bismuth and antimony replacing each other isomorphically.

L. Figuier.—"*L'Année Scientifique Industrielle,*" 6th year, 1862. Every scientific movement which has taken place during the year 1861, is related in this little work which is devoted principally to the practical application of scientific facts. The work is in its sixth year and its success is already assured.

Zeller.—"*Année Historique,*" II.—This periodical takes the place in reference to history that the Année Scientifique holds in reference to the applied sciences. It is an annual review of the questions and political events of the principal states of the whole world. Its author, M. Zeller, is the Professor of History at the Normal School of Paris and finds himself by position as well as from preference profoundly versed in those subjects which he treats in this review.

Pietra Santa.—"*Chemins de Fer et Santé Publique.*" 1861, 12mo. This work devoted chiefly to the hygiene of travellers by railways and also that of employées (upon railways) draws the conclusion that:—Railroads exercise a happy influence upon health. He examines carefully all that relates to this question; for example the *Daltonism* or *Pseudochromotopsy* (color-blindness), an affection which is attended with danger when it is a railway employée who is affected. The work closes with extensive bibliography of all which has been published upon the subject.

Jules Simon.—*L'Ouvriere*, in 12mo, 4th edition. 1862. This work of high moral and social position, is principally devoted to the different questions relating to operatives in modern workshops, especially those situated in France. Its author, one of the most independent and celebrated of living philosophers, has recorded in this little work the results of observations continued for many years in different manufacturing centres in France. There is not a manufacturing town which he has not visited with care, as well as the different organizations established to improve the condition of the laboring people.

M. Jules Simon gives the preference to the city manufacturers of Mulhouse, organized under the direction of the Industrial Society of this important manufacturing town.

Cournet.—*Traité de l'Enchainement des Indées dans les Sciences et dans l'Histoire.* 2 vols. 8vo. 1861. See this Jour., xxxi, 111.

Charles Roger Bacon: Sa Vie; *ses Ouvrages des Doctrines, d'Après des Textes Inédits.* 1 vol. 8vo. 1861. See this Jour. xxxiii, 110.

Quatrefages. Unité de l'Espéce Humaine. 1 vol. 12mo. 1861.—This work is a resumé of the lectures delivered by the author as Professor of Anthropology at the Museum of Paris. He has given an affirmative answer to this question, recently contested in view of the latest geological discoveries. (See correspondence in this Journal, [2], xxix, p. 269.)

Lecoq.—*La Vie des Fleurs.* 1 vol. 12mo. 1861.—We have frequently mentioned the valuable labors of Lecoq the Naturalist, Professor of Natural History to the Faculty of Sciences of Clermont, and a Correspondent of the Institute. This new work is especially designed for the use of the masses. The vegetation of the entire globe is passed in review and considered in its relations both to men and animals, an easy task for Mr. Lecoq since he is at once a botanist, physiologist and geologist, and he is the one who has made known to the scientific world the central plateau of France, including the mountains of Auvergne.

Paul Marcoy.—Scènes et Paysages dans les Andes.—Eight years sojourn in the Cordilleras of the Andes has enabled Mr. Marcoy to study the manners of the inhabitants of those elevated regions. He visited the principal mountains and was the first to attempt the ascent of the *Urusayhua.* This daring traveller has published his adventures and observations in a style at once picturesque and entertaining.

Chez H. BOSSANGE, Librarie Quai Voltaire à PARIS.

A. Delesse.—Etudes sur le Métamorphisme des Roches. Large Quarto. 1861.—This work contains the important researches which we have formerly reported and which have been honorably noticed by the Academy of Science. Mr. Delesse has treated principally upon general or normal metamorphism. Considering the condition in which combustibles are arranged, as well as calcareous rocks, sandstones and clays, the author has studied their successive metamorphisms. They have for their extreme limit the *anthracite* or the *graphite*, the *white marble*, the quartz, the *mica-schist*, and the *gneiss*. In the same manner he has investigated the metamorphisms of the metalliferous rocks, especially those which are more common in nature. The ores of iron, copper, and zinc are successively examined. Trachyte, basalt, and the recent volcanic rocks ought equally to undergo metamorphisms analogous to the preceding, and Mr. Delesse thinks that these rocks are transformed into granite and into diorite.

V. Meunier.—De l'Orfévrerie Electro-Chemique; Histoire et Description. 1 vol. 12mo. 1861.—It is very generally admitted that electro-chemical gilding was invented by de Ruolz, and in France especially this name has become proverbial. Mr. Victor Meunier attempts to demonstrate the contrary, and he brings some very strong evidence to support his views. According to his view the real inventor or the inventors were first Brugnatelli and afterwards Elkington. M. de Ruolz has merely come after them and has not even perfected the processes; such is the conclusion of the book. It is necessary to refer to the book for the documents. Our readers know that Meunier is one of the most eminent popular authors in France. His book is being extensively read and it produces a great sensation, as would be anticipated from his attempt to overthrow the honor of a name which has already become popular.

SCIENTIFIC INTELLIGENCE.

I. PHYSICS AND CHEMISTRY.

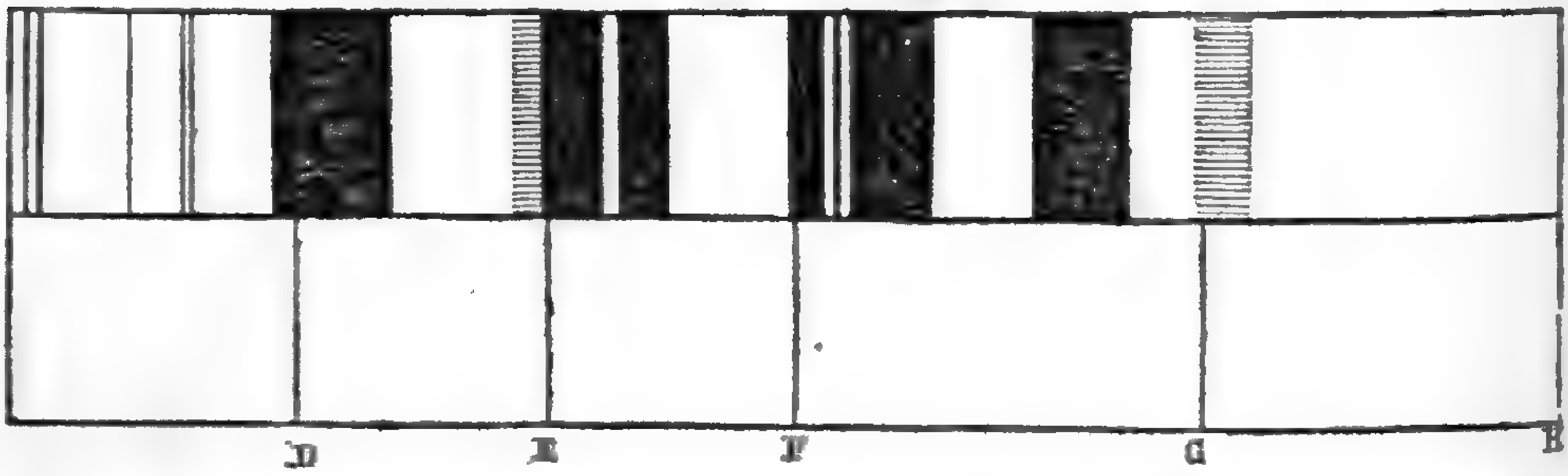
PHYSICS.

1. *On the Spectrum afforded by solution of Nitrate of Didymium.* (From a letter of Professor O. N. ROOD to Dr. WOLCOTT GIBBS.)—You will remember calling my attention to the curious fact, that Gladstone had discovered two dark lines in the spectrum furnished by light transmitted through dilute solutions of the nitrate of didymium.

I have lately repeated the experiment with the sample of this substance you kindly placed at my disposal, using quite strong solutions of considerable thickness; below is a sketch of the results obtained, which may prove of interest to you.

When the light of a lamp or sunlight is transmitted through a tube 12 inches in length, containing a strong solution of the salt in question, and afterwards analyzed by the spectroscope of Bunsen and Kirchhof, the spectrum is seen crossed by twelve distinct lines or bands, some being very broad, while others are quite fine and require a prism of high dispersive power to effect their resolution.

Annexed is a drawing obtained by micrometrical measurements, showing their position as compared with some of the fixed lines in the solar spectrum.



D, or the sodium line is just cut off by one of these broad bands, and from this results the singular circumstance that the sodium flame becomes invisible when merely viewed through a foot of the solution, though white objects examined in the same manner appear but slightly altered in tint. This, I think, is the only case we know of where the orange ray is cut off by a nearly colorless medium.

Very sincerely, O. N. Rood.

Troy, May 21st, 1862.

2. *Effect of powdered Ice in water boiling in Glass Vessels;* by Prof. P. A. Chadbourne, of Bowdoin College.—The common experiment of pouring iron filings into water slowly boiling in smooth glass vessels to increase the ebullition can be instructively varied by substituting powdered ice or granular snow for the iron filings. Snow that has thawed partially and then frozen so as to become hard and granular is the best, but powdered ice will answer if kept so cold by freezing mixture as to be perfectly dry. If a spoonful of this ice or snow be thrown into a smooth flask nearly filled with water slowly boiling, intense ebullition at once takes place, a portion of the water being thrown out of the flask. The particles of ice thus act like particles of iron or sand, before they have time to melt and set free the steam.

3. *Galvanic Experiment.*—It is well known that the directions for repeating this experiment are, that one metal shall touch the *nerve* of the frog, the other metal the *muscle.* If instead of this arrangement the nerve be dissected out from the thigh of the frog and the current passed through the *nerve alone* the movement of the leg will be equally great. In fact, passing a current directly through one section of the nerve will produce contraction, one end of the nerve may be separated and wound like a thread around one wire, then by touching any portion of the nerve thus separated so as to pass a current through it, contractions will be produced. By touching one wire to the muscle as generally directed we have the contractions of course, because the moist muscle acts as a *conductor*; but from these experiments it would seem that the effect is produced only *by the passage of the current through a portion of the nerve.*

Chemistry.

4. *On the Oxyd of Ethylene.*—Wurtz has obtained a remarkable compound of bromine with oxyd of ethylene by mixing the two substances

in a sealed tube and allowing the mass to stand over night in a cooling mixture. Ruby-red prisms are formed which melt at 65° C. and boil at 75° C. They are insoluble in water, but soluble in alcohol and ether and have a penetrating smell. Wurtz assigns to this body the formula

$$\left.\begin{matrix} C_4H_4O_2 \\ C_4H_4O_2 \end{matrix}\right\} Br_2 \quad \text{or} \quad \left.\begin{matrix} C_2H_4O \\ C_2H_4O \end{matrix}\right\} Br_2$$

Treated with metallic mercury these crystals yield bromid of mercury and a colorlesss liquid which has a faint but agreeable smell, solidifies after fusion at +9° C. and boils at 102° C. The formula of this liquid is

$$\left.\begin{matrix} C_4H_4O_2 \\ C_4H_4O_2 \end{matrix}\right\}$$

and the author considers it as the ether of diethylene alcohol; its derivation from this last may be represented by the equation

$$\left.\begin{matrix} C_4H_4 \\ C_4H_4 \\ H_2 \end{matrix}\right\} O_6 - 2HO = \left.\begin{matrix} C_4H_4O_2 \\ C_4H_4O_2 \end{matrix}\right\}$$

Dyoxyethylene is soluble in all proportions in water, alcohol and ether, and combines with difficulty with anhydrous acetic acid.

When an aqueous solution of oxyd of ethylene is treated with an amalgam of sodium ordinary alcohol is formed, the equation being

$$C_4H_4O_2 + H_2 = C_4H_6O_2$$

Equal volumes of vapor of oxyd of ethylene and chlorhydric acid unite instantaneously and form chlorhydrate of oxyd of ethylene or glycol-monochlorhydrin.—*Comptes Rendus*, liv, 277. W. G.

5. *On new modes of forming certain hydrocarbons.*—Wurtz has studied the action of zinc-ethyl upon iodid of allyl, and has obtained in this manner hydruret of amyl, amylene, allylene and ethylene. The formation of amylene may be represented by the equation

$$C_4H_5 + C_6H_5 = C_{10}H_{10}$$

The other substances are produced by the reaction indicated by the equation

$$(C_4H_5)_2Zn_2 + 2C_6H_5I = Zn_2I_2 + C_{10}H_{12} + C_6H_4 + C_4H_4$$

Other hydrocarbons with a higher boiling point are also formed: one of these appears to be dyamylene, $C_{20}H_{20}$.—*Comptes Rendus*, liv, 387.

6. *On Hyperchloric Acid.*—Roscoe has carefully studied the hydrates and principal salts of hyperchloric acid. The acid may be advantageously obtained by decomposing chlorate of potash with fluosilicic acid, distilling the chloric acid and purifying the distillate by means of the hyperchlorates of silver and of barium. Pure concentrated solution of hyperchloric acid is a colorless heavy oily liquid which strongly resembles concentrated sulphuric acid. When this acid is distilled with four times its volume of concentrated sulphuric acid, a decomposition takes place at 110° C., dense white vapors pass off while a yellow insoluble liquid condenses: at 200° C. oily drops pass over and condense to a crystalline mass. The liquid is hyperchloric acid ClO_8H; the crystals are the hydrate discovered by Serullas $ClO_8H + 2HO$. Pure hyperchloric acid, ClO_8H, is a colorless liquid of density 1·782 at 15° C.: its vapor is transparent and colorless but it forms thick white fumes in the air by attracting water. When dropped

into water the acid produces a hissing noise and the mixture is strongly heated. A drop of the acid allowed to fall on paper, wood, &c., produces explosion: on charcoal the drop explodes almost as violently as chlorid of nitrogen. The acid mixes quietly with alcohol, with evolution of heat, and formation of ether; once however a violent explosion was produced. With ether the acid uniformly explodes violently and the author suggests that possibly the hyperchloric ether of Hare and Boyê is formed. Hyperchloric acid produces upon the skin a painful wound which only heals after some months. The acid is decomposed by distillation, hyperchloric acid gas and an explosive liquid having the color of bromine being formed. Hyperchloric acid is spontaneously decomposed on keeping, even in the dark, gradually becoming darker colored and finally exploding suddenly. The hydrate of Serullas crystallizes in long needles which give off dense white vapors in the air and deliquesce rapidly. Their fusing point is 50° C. Their action on organic substances is less violent than that of the pure acid but they ignite paper and wood. The concentrated aqueous solution of hyperchloric acid contains from 71–72 per cent of ClO_8H and boils at 203° C. The author describes the hyperchlorates of ammonium, copper-ammonium, protoxyd of iron, suboxyd of mercury and lead.—*Ann. der Chemie und Pharmacie*, cxxi, 346. W. G.

7. *On hyponitric acid.*—Müller has studied the action of chlorhydric acid upon hyponitric acid obtained by the distillation of nitrate of lead. Crystallized hyponitric acid, NO_4, was found to melt at 11° 5–12° C., it absorbs chlorhydric acid readily at −22° C. and gives a yellowish-red liquid which toward the end of the operation gives off chlorine. By repeated and careful distillations two liquids were obtained, the boiling points of which were respectively −5° C. and +5° C., and nearly constant. Of these the more volatile proved to be Gay Lussac's compound NO_2Cl: the other had the formula NO_4Cl. The density of this liquid was found to be 1·32 at 14° C.; its vapor density was 2·63 by observation, 2·8 by calculation. The compound NO_4Cl is instantly decomposed by water yielding chlorhydric and nitric acids according to the equation

$$\left.\begin{matrix}NO_4\\Cl\end{matrix}\right\}+2HO=\left.\begin{matrix}NO_4\\H\end{matrix}\right\}O_2+HCl$$

The author suggests that the molecule $\left.\begin{matrix}NO_4\\Cl\end{matrix}\right\}$ may serve to introduce (NO_4) into organic compounds. Pentachlorid of phosphorus acts violently upon hyponitric acid, the reaction being expressed by the equation

$$NO_4+PCl_5=NO_2Cl+PO_2Cl_3+Cl$$

The vapor-density of hyponitric acid was found to be 2·70 at 28° C. and 1·84 at 79° C.; the formula NO_4 requires 1·59; the formula N_2O_8 requires 3·17. Müller considers it desirable to write the formula of the liquid acid $\left.\begin{matrix}NO_4\\NO_2\end{matrix}\right\}O_2$, or $\left.\begin{matrix}N\Theta_2\\N\Theta\end{matrix}\right\}\Theta$, which in fact corresponds with Berzelius's view that the acid is a compound of nitric and nitrous acids. Pure fluid hyponitric acid acts upon metals in such a manner that a nitrate is formed while deutoxyd of nitrogen is set free, this combines with NO_4 to form nitrous acid: the reaction is $\left.\begin{matrix}NO_4\\NO_2\end{matrix}\right\}O_2+R=\left.\begin{matrix}NO_4\\R\end{matrix}\right\}$

O_2+NO_2. The action of hyponitric acid upon metallic oxyds yields a nitrate and nitrous acid. The action of hyponitric acid upon sulphuric acid has been studied by Weltzien. In repeating the experiments of this chemist Müller obtained the same crystalline compound and the same formula, $SO_3HO+SO_3NO_4$.—*Ann. der Chemie und Pharm.*, xlvi. 1.

W. G.

8. *On the sulphids of the alcohol radicals.*—CARIUS and FERREIN have obtained two oxysulphids of glycerin to which they give the names of glycerin-monosulphydrate and glycerin-disulphydrate. The compounds in question are obtained by the action of monochlorhydrin $\left.\begin{matrix}C_6H_5\\H_2\end{matrix}\right\}\begin{matrix}O_4\\Cl\end{matrix}$ and $\left.\begin{matrix}C_6H_5\\H\end{matrix}\right\}\begin{matrix}O_2\\Cl_2\end{matrix}$ upon an alcoholic solution of sulphid of potassium. Both are oily liquids, having a faint odor of mercaptan; they are soluble in water and decomposed by distillation. The first compound has the formula $\left.\begin{matrix}C_6H_5\\H_3\end{matrix}\right\}O_4S_2$; the second is represented by $\left.\begin{matrix}C_6H_5\\H_3\end{matrix}\right\}O_2S_4$. Oxyd of mercury acts upon the disulphur compound as upon mercaptan and forms a white salt having the formula $\left.\begin{matrix}C_6H_5\\Hg_2H_8\end{matrix}\right\}O_2S_4$.—*Ann. der Chemie und Pharm.*, xlvi, 71.

W. G.

9. *On certain Ammonia-ruthenium Bases.*—CLAUS has discovered and described two conjugate bases containing ammonia and ruthenium, and to which he gives respectively the names of *ruthenamiak* and *ruthenbiamiak*. The author considers these bodies as containing the conjugate radicals $\widehat{NH_3}Ru$, and $2\widehat{NH_3}Ru$, which unite with an equivalent of oxygen chlorine, etc. The salts of ruthenamiak alone are described in detail; the chlorid $2\widehat{NH_3}RuCl$ is easily formed by boiling a solution of chlor-ruthenate of ammonium $\widehat{RuCl_2,}NH_4Cl$ with ammonia, evaporating the orange yellow solution to dryness, and washing the dry mass to remove sal-ammoniac. The chlorid is a beautiful yellow crystalline salt, having the formula $2\widehat{NH_3.}RuCl+3HO$. The sulphate of this base contains four, the nitrate two, and the carbonate five equivalents of water. The free base exists only in solution; it has a strong alkaline reaction and its solution can be tasted only with the utmost caution, as it produces a very painful affection of the tongue. It precipitates many metallic oxyds, and may be substituted for potash in Trommer's test for sugar. The author describes only the oxyd of ruthenamiak which has the formula $\widehat{NH_3}RuO+5\,HO$, and is obtained when a solution of the last base is evaporated to dryness. This oxyd is dark yellow and crystalline; it appears to be still more caustic than the oxyd of ruthenbiamiak, and produces an even more painful disease of the tongue when tasted. In the same memoir Claus reviews the researches of Deville and Debray, and gives some modifications of his own process for resolving osmiridium and for the separation of the platinum metals.—*Journal für prakt. Chemie*, 85, p. 129, *from Bullet. de l'acad. imp. des sciences de St. Petersbourg*, T. iv.

W. G.

10. *On a method of preparing Chlorinated Organic Bodies.*—HUGO MÜLLER finds that the replacement of hydrogen in organic bodies by

chlorine may be facilitated in an extraordinary degree by dissolving iodine in the body to be acted on, and then passing chlorine directly into the solution. In this manner benzol yields the fluid compounds $C_{12}H_5Cl$, $C_{12}H_4Cl_2$ and $C_{12}H_3Cl_3$, chlorhydric acid being evolved. Benzoic acid dissolved in chloroform is easily attacked by chlorine; bisulphid of carbon, containing iodine in solution, is decomposed by chlorine at a gentle heat, yielding chlorid of sulphur and chlorid of carbon. Large quantities of chloracetic acid may be prepared in a similar manner, even in the dark. The author believes that in most cases the iodine acts simply as a condenser of chlorine, and compares the reaction with that of the super-chlorids of phosphorus and antimony.—*Zeitschrift für Chemiè und Pharmacie*, 1862, p. 99. W. G.

Applied Chemistry.

11. *The Tannin Process;* by Prof. Edwin Emerson, Troy.—Photography on dry plates possesses so many advantages over the wet processes for outdoor work, that great attention has been given by scientific photographers to experiments in this department with a view either to devise some entirely new method which should not be subject to the defects attending the old methods, or so to improve some one of the known processes as to render it more easy and certain in the practical working. The vast amount of laborious research which has been made to this end, can only be appreciated by those who are familiar with the practice of Photography in its different branches.

Among the dry processes, the *Collodio-Albumen* and the *Fothergill* have, until very recently, received the most attention, and in the hands of adepts have given excellent results. But as success in these methods depends greatly upon the mechanical state of the collodion, and the favorable condition of the sensitizing bath, it is evident that neither of them can be worked with certainty by the generality of operators.

Major C. Russell, of England, after a series of experiments extending through five or six years, has perfected a dry process, now known as *the Tannin Process.* Its advantages may be briefly summed up as follows:—1. It is simple. 2. It is not dependent upon the mechanical state of the collodion. 3. A sensitizing bath in ordinary working condition is sufficient. 4. The development of the latent image is under complete control. 5. It gives, if desired, great intensity. 6. It affords an excellent *tone.* 7. The prepared plates will keep well both before and after exposure. 8. The silver, in the development is thrown down in a very finely divided state, and it is thus more favorable for obtaining extreme sharpness.

As might have been expected this process has excited great interest in the photographic world. Many experiments have been made upon it, and thus far the testimony has been uniformly in its favor. Our own observations have extended through a year and experience corroborates fully the favorable estimate which has been formed of it by others.

We give now the details of this process as worked by us:—The plate should be very carefully cleaned, and must be perfectly dry before coating with collodion; it is coated and sensitized in the same manner as for the wet process; it is then washed thoroughly in pure water, with five or six changes of water; a good plan is to have a succession of baths of pure water into which the plate can be dipped successively without removing the plate from the dipper, as recommended by my friend F. F. Thompson, Esqr. (see *Seely's Journal* for May, 1862). After being thus washed with water it is flowed with or dipped into a bath composed of fifteen grains of Tannin dissolved in each ounce of pure water, the solution being carefully filtered. The plate should remain in this bath four or five minutes. It is then drained, and set up on one corner, on bibulous paper, to dry in a dark room or box. The ordinary exposure necessary is about four times as long as a wet plate. Two solutions are used in the development—No. 1. Pyrogallic acid 72 grains to an ounce of 95 per cent alcohol. No. 2. Nitrate of silver 20 grains, citric acid 40 grains, pure water one ounce. To develop—wet the plate rapidly with pure water, when the film is thoroughly moistened, flow the plate with water, to each drachm of which has been added two drops of No. 1, and one drop of No. 2; keep this developer in motion over the plate until the details are well out, then add to it drop by drop of No. 2, until the required intensity is obtained. Fix in hyposulphite of soda as usual.

Experience in the use of this process teaches—1. That drying by artificial heat is not necessary. 2. That the amount of acid in No. 2 may be judiciously varied with the length of exposure. It is better to have an excess of acid than too little. 3. Warming the plate in a bath of water heated 90° F., but using the developing solutions at the usual temperature, as recommended by Dr. Draper, of New York, and others, shortens the time of exposure necessary, so that this process may be worked almost as rapidly as the wet. 4. By the use of honey in combination with the Tannin, fifteen grains of each to the ounce of water as recommended by Mr. England, of London, great rapidity is gained. 5. A bromo-iodized collodion is to be preferred, and an old collodion works better in my hands than a new sample. 6. The silver bath should not be neutral, but ought to be decidedly acid; this may be done by adding one drop of nitric acid for every twelve ounces of bath. 7. This process is peculiarly adapted to the production of glass transparencies for the Stereoscope, affording great beauty and richness of tone.

II. GEOLOGY.

1. *Geology of Vermont.*—We would call attention again to the Report on the Geology of Vermont, noticed in our last volume. The work is in two volumes quarto, in all 990 pages, with numerous illustrations, besides a colored geological map of the State, and is offered for the moderate sum of five dollars. The geology of Vermont has a special interest on account of the intimate connection within the borders of the State, of metamorphic and fossiliferous rocks, and in some cases the occurrence of the latter underneath the former, or the one passing into the other. The volumes also treat very fully of the phenomena of the drift, of the river and lake terraces, elevated sea-beaches, and the fossils of the post-tertiary; also at length of the economical products of the state. With regard to copies of the work, letters should be addressed to Albert D. Hager, Proctorsville, Vermont.

2. *Mastodon tooth in Amador Co., California.*—Remains of the mastodon have been very rarely found in California. Dr. Logan of Sacramento, has sent us two photographic views of what appears to be the 6th upper

molar of *Mastodon giganteus.* This tooth was found by a miner some twenty feet below the surface, while digging for gold on Indian Creek, one of the tributaries of the Cosumnes River near Drytown, Amador county, at an elevation of about 900 feet above the sea. This discovery is interesting as showing the geographical range of the Mastodon to have been coëxtensive with the continent and not limited as some have supposed to the eastern slope of the Rocky Mountains.

3. *New species of Silurian fossils;* by E. BILLINGS, F.G.S., Palæontologist G. S. Canada. Montreal, 6th June, 1862. pp. 67–168, 8vo.—This is a continuation of the papers formerly noticed (this Journal, [2], xxxiii, 136, 279) and contains descriptions of one hundred and six new species of fossils from the Silurian rocks of Canada with remarks upon others previously published. The new genera proposed are (1) LICROPHYCUS for a group of fucoids; (2) SHUMARDIA, a genus of minute trilobites allied to *Agnostus;* (3) ENDYMION for a genus of trilobites allied to both *Ampyse* and *Trinucleus* and apparently standing between these two genera; (4) TRIMERELLA, consisting of large brachiopods with three longitudinal septa in each valve supporting a flat or concave plate to which a portion of the muscular apparatus was attached, the beak solid and the area transversely striated as in the genus *Obolus.* About ninety of the species are figured.

4. *True position of the so-called Waukesha Limestone of Wisconsin.* (In a letter from Dr. C. ROMINGA, of Ann Arbor.)—In the local description of the Silurian strata exposed in the neighborhood of Milwaukee, a certain calcareous stratum or a complex of such is called *Waukesha limestone,* and was considered as being the base of the thick bedded fossiliferous lime rocks, considered as synchronic with the Niagara limestones.

A careful examination proves beyond all doubt, that the Waukesha limestone is in reality the superincumbent rock, and that the Niagara limestone only in disseminated spots protrudes by volcanic action in domelike knobs through the otherwise nearly horizontal or merely undulating strata of the Waukesha limestone.

5. *Note on the Description of Lingula polita.*—We have received the following statement called out by a charge made in the paper by Mr. Billings, in the last volume of this Journal, page 420.—EDS.

Albany, May 12, 1862.

I certify that on the ninth day of February, 1861, I sent to Captain James Anderson, at that time of the Cunard Steam Ship "Canada," a box of fossils, among which were some specimens of Potsdam Sandstone from Trempaleon, Wisconsin, containing small Linguloid shells, given to me by Prof. James Hall, under the name *Lingula polita;* which name was written upon the labels sent with the specimens.

Without being able to designate the precise time, I know of my own knowledge, that at a time previous to the date specified above (9th of February 1861), Prof. Hall had made comparisons of this small fossil, with the figures and descriptions of Dr. D. D. Owen; who had designated it as *Obolus apolinus?* and that its relation to Obolus and its differences therefrom, as exhibited in figures given by Davidson, were fully discussed by Prof. Hall and myself.

[Signed] R. P. WHITFIELD.

6. *Descriptions of new Lower Silurian (Primordial), Jurassic, Cretaceous, and Tertiary Fossils, collected in Nebraska, by the Exploring Expedition under the command of Capt. Wm. F. Raynolds, U. S. Top. Engrs.; with some remarks on the rocks from which they were obtained;* by F. B. Meek and F. V. Hayden.—We have received a copy of the valuable memoir with the above title, from which we copy the following sections:

GENERAL SECTION OF THE CRETACEOUS ROCKS OF NEBRASKA.

Series	Formation	Divisions and Subdivisions.	Localities.	Estim'd thickn's.	Equivalents
Upper Series.	Fox Hills beds. Formation No. 5.	Gray, ferruginous and yellowish sandstone and arenaceous clays, containing *Belemnitella bulbosa, Nautilus Dekayi, Ammonites placenta, A. lobatus, Scaphites Conradi, S. Nicolletti, Baculites grandis, Busycon Bairdi, Fusus Culbertsoni, F. Newberryi, Aporrhais Americana, Pseudo-buccinum Nebrascensis, Mactra Warrenana, Cardium subquadratum*, and a great number of other molluscous fossils, together with bones of *Mosasaurus Missouriensis*, &c.	Fox Hills, near Moreau River, — near Long Lake above Fort Pierre. Along base Big Horn Mountains, and on North and South Platte Rivers.	500 feet.	Eq. Upper or White Chalk and Maestricht beds. (*Senonien*, D'Orbigny.)
	Fort Pierre Group. Formation No. 4.	Dark gray and bluish plastic clays, containing near the upper part *Nautilus Dekayi, Ammonites placenta, Baculites ovatus. B. compressus, Scaphites nodosus, Dentalium gracile, Crassatella Evansi, Cucullæa Nebrascensis, Inoceramus Sagensis, I. Nebrascensis, I. Vanuxemi*, Bones of *Mosasaurus Missouriensis*, &c., &c., &c.	Sage Creek, Cheyenne River and on White River above the Mauvaises Terres.	700 feet.	
		Middle zone nearly barren of fossils.	Fort Pierre and out to Bad Lands,—down the Missouri on the high country to Great Bend.		
		Lower fossiliferous zone, containing *Ammonites complexus, Baculites ovatus, B. compressus, Helicoceras Mortoni, H. tortum, H. umbilicatum, H. cochleatum, Ptychoceras Mortoni, Fusus vinculum, Anisomyon borealis, Amauropsis paludiniformis, Inoceramus sublaevis, I. tenuilineatus*, bones of *Mosasaurus Missouriensis*, &c.	Great Bend of the Missouri, below Fort Pierre.		
		Dark bed of very fine unctuous clay, containing much carbonaceous matter, with veins and seams of gypsum, masses of sulphuret of iron and numerous small scales of fishes. Local; filling depressions in the bed below.	Near Bijou Hill, on the Missouri.		
	Niobrara Division. Formation No. 3.	Lead-gray calcareous marl, weathering to a yellowish or whitish chalky appearance above. Containing large scales and other remains of fishes, and numerous specimens of *Ostrea congesta* attached to fragments of *Inoceramus*. Passing down into light, yellowish and whitish limestone, containing great numbers of *Inoceramus problematicus, I. pseudo-mytiloides, I. aviculoides* and *Ostrea congesta*, fish-scales, &c.	Bluffs along the Missouri below the Great Bend, to the vicinity of Big Sioux River; also below there on the tops of the hills.	200 feet.	Eq. Lower or Gray Chalk (and Upper G. Sand?) of British Geologists. (*Turonien* and *Cenomanien*? of D'Orbigny.)
Lower Series.	Fort Benton Group. Formation No. 2.	Dark gray laminated clays, sometimes alternating near the upper part with seams and layers of soft gray and light-colored limestone. *Inoceramus problematicus, I. tenuirostratus, I. latus? I. fragilis, Ostrea congesta, Venilia Mortoni, Pholadomya papyracea, Ammonites Mullani, A. percarinatus, A. vespertinus*,* *Scaphites Warreni, S. larvæformis, S. ventricosus, S. vermiformis, Nautilus elegans?* &c.	Extensively developed near Fort Benton on the Upper Missouri; also along the latter, from ten miles above James River to Big Sioux River, and along the eastern slope of the Rocky Mountains, as well as at the Black Hills.	800 feet.	
	Dakota Group. Formation No. 1.	Yellowish, reddish and occasionally white, sandstone, with at places, alternations of various colored clays and beds and seams of impure lignite. Also silicified wood, and great numbers of leaves of the higher types of dicotyledonous trees; with casts of *Pharella? Dakotensis, Axinaea Siouxensis*, and *Cyprina arenarea*.	Hills back of the town of Dakota; also extensively developed in the surrounding country in Dakota County below the mouth of Big Sioux River, — thence extending southward into Northeastern Kansas and beyond.	400 feet.	

* This is *A. Texanus* of Roemer. It is on the authority of Mr. Gabb that it is here regarded as identical with *A. vespertinus* of Morton. We should never have suspected this from Dr. Morton's figure, but Mr. Gabb assures us that after a careful comparison with Dr. Morton's specimen, he can see no difference.

GENERAL SECTION OF THE TERTIARY ROCKS OF NEBRASKA.

Names.	SUBDIVISIONS.	Thickness.	LOCALITIES.	Foreign equivalents.
Loup River beds.	Fine loose sand, with some layers of limestone,—contains bones of *Canis*, *Felis*, *Castor*, *Equus*, *Mastodon*, *Testudo*, &c., some of which are scarcely distinguishable from living species. Also *Helix*, *Physa*, *Succinea*, probably of recent species. All fresh water and land types.	300 to 400 feet.	On Loup fork of Platte River; extending north to Niobrara River, and south to an unknown distance beyond the Platte.	Pliocene.
White River Group.	White and light drab clays, with some beds of sandstone, and local layers of limestone. Fossils, *Oreodon*, *Titanotherium*, *Chæropotamus*, *Rhinoceros*, *Anchitherium*, *Hyænodon*, *Machairodus*, *Trionyx*, *Testudo*, *Helix*, *Planorbis*, *Limnæa*, petrified wood, &c. &c. All extinct. No brackish water or marine remains.	1000 feet or more.	Bad Lands of White River; under the Loup River beds, on Niobrara, and across the country to the Platte.	Miocene.
Wind River Deposits.	Light gray and ash colored sandstones, with more or less argillaceous layers. Fossils, fragments of *Trionyx*, *Testudo*, with large *Helix*, *Vivipara*, petrified wood, &c. No marine or brackish water types.	1500 to 2000 feet.	Wind River valley. Also west of Wind River Mountains.	?
Fort Union or Great Lignite Group.	Beds of clay and sand, with round ferruginous concretions, and numerous beds, seams and local deposits of Lignite; great numbers of dicotyledonous leaves, stems, &c. of the genera *Platanus*, *Acer*, *Ulmus*, *Populus*, &c., with very large leaves of true *fan-palms*. Also, *Helix*, *Melania*, *Vivipara*, *Corbicula*, *Unio*, *Ostrea*, *Potamomya*, and scales of *Lepidotus*, with bones of *Trionyx*, *Emys*, *Compsemys*, *Crocodilus*, &c.	2000 feet or more.	Occupies the whole country around Fort Union, — extending north into the British possessions, to unknown distances; also southward to Fort Clark. Seen under the White river Group on North Platte River above Fort Laramie. Also on west side Wind river mountains.	Eocene?

III. BOTANY AND ZOOLOGY.

1. *On the Various Contrivances by which British and Foreign Orchids are Fertilized by Insects, and on the Good Effects of Intercrossing.* By CHARLES DARWIN, M.A., F.R.S., &c. With illustrations. [34 figures, on wood.] London: Murray, 1862. 24mo, pp. 365.

Of all books relating to the realm of nature, perhaps the most attractive to old and young are those (such as the writings of Reaumur and Huber) which describe the habits and doings of insects. Here is a new volume of this class, bringing to view some of the numerous and most curious contrivances (a great part of them now first made known) through which insects are found to benefit the plants that nourish them. We all know how essential plants, and especially their flowers, are to the existence of the multitudinous swarms and tribes of insects; but it is hardly understood that the benefit is reciprocal,—that, in the long run, insects are also essential to the continued existence of many, if not of most species of plants. "The object of the following work," the author states, "is to show that the contrivances by which Orchids are fertilized are as varied and almost as perfect as any of the most beautiful adaptations in the animal kingdom; and, secondly, to show that these contrivances have for their main object the fertilization of each flower by the pollen of another flower." 'Adaptations'—many of them truly exquisite—and 'contrivances,' they may well be termed, being obviously as evincive of design as are analogous arrangements in the animal kingdom, from which intention is so irresistibly inferred. Indeed, had Mr. Darwin begun with this little book, and kept back a few theoretical inferences, it would have been a treasury of new illustrations for the natural theologians, and its author, perhaps, rather cannonized than anathematized, even by many of those whom his treatise on the origin of species so seriously alarmed. With how much reason, and where there may have been grounds for alarm, how far some of the positions assumed were safe and tenable, or wise, it is not our present business to consider. Our author remarks that this treatise affords him "an opportunity of attempting to show that the study of organic beings may be as interesting to an observer who is fully convinced that the structure of each is due to secondary laws, as to one who views every trifling detail of structure as the result of the direct interposition of the Creator." But the present book is almost wholly a record of observed facts, of curious interest, irrespective of all theories of origination, and perhaps as readily harmonized with old views as with new—with direct as well as with indirect creation.

The drawbacks to the general perusal and high enjoyment of this, to us so fascinating, little volume, are, first, that it demands some knowledge of botany, and the patience to master needful details, perhaps "too minute and complex for any one who has not a strong taste for natural history." But whoever will master the details, will be richly repaid for the trouble. Secondly, the Orchids illustrated are mainly British species; but several of them have close representatives in the United States, a few even are identical; and, with Darwin's treatise as a guide, the study of the fertilization of our own species will seldom be difficult, will even be all the more enticing for the chance of some novelty in the exploration of a new field. Whoever shall first study carefully the fertilization of the Orchids peculiar to this country, may hope to add something to what is now known upon this curious subject. Moreover, we are rich in the *Ophrydeæ*, or the proper Orchis tribe, with which this treatise commences, which are easy of observation, and yield to none in curious interest.

We have, indeed, only one true *Orchis* to represent the numerous European species; and this, the pretty *Orchis spectabilis*, just now in perfection throughout the northern part of the country, will be out of flower before these pages are in print. Next spring, Mr. Darwin's graphic account of the contrivance by which the pollen of one flower of *O. mascula* is made to fertilize the stigma of another flower, may be verified in all essential particulars upon our own species. The structure of the blossom being understood, or learned from the ordinary botanical works, it will be interesting to note how the pollen in each cell of the anther, tied up by delicate threads to a common stalk, although placed just above and tantalizingly close to the stigma, is incapable of reaching it; how the common stalk of each pollen mass is firmly attached to a sticky gland, belonging to the upper part of the stigma; how these two glands, or balls of viscid matter, standing side by side, are enclosed in a little pouch, which shelters the viscid balls from the air, and keeps them soft and moist; how the slightest touch of the closed pouch from above will rupture it, transversely along the top, so that the anterior part of the pouch, depressed by a slight force, will expose the sticky glands, but will rise and cover them again when the pressure is removed; how this apparatus stands projecting just over the posterior border of the entrance into the long, nectar-bearing tube or spur, which, moths, butterflies, bees, or other insects with long proboscis visit, to suck out the nectar; how a bristle, representing the proboscis, or a sharpened pencil representing the head of an insect, inserted into the spur, will, by depressing the pouch, come into contact with the glands; when their glutinous matter, promptly hardening, like a cement, will adhere firmly to what they touch; and how, on withdrawal, one or both pollen masses, attached to the gland by their stalk or caudicle, will be drawn out of their cells and carried away; how, through a curious, probably hygrometic change of form or unequal contracility of the viscid gland, now attached to the object, the pollen-masses turn forward or become depressed, within a minute or so; and how, on returning the bristle or pencil-point to its former position, or inserting it into the nectar of another flower, the pollen will now be almost surely brought into contact with the broad viscid stigma situated just beneath the pouch and anther and the viscidity of the stigma is such, that sometimes the whole pollen mass will be left on it, but usually only a small part of it. For the elastic threads which bind the numerous packets of pollen to their common support or stalk, being weaker than the attachment of the gland to the proboscis or other object on the one hand, and than the cohesion of the pollen to the glutinous stigma on the other, some of these packets of pollen will be torn away from the mass and left on the stigma; others upon the stigma of the next flower visited, and so on.

The whole contrivance here is obvious and admirable. The hollow spur secreting nectar attracts insects, and will be habitually visited by those furnished with a proboscis adapted to reach the attractive liquid. The sticky glands are placed just where the probociss or the head of the insect must needs come in contact with them; and the protecting pouch preserves their viscidity (which here is quickly lost by drying) for the moment when it is turned to useful account. The pollen masses extracted from one flower must needs be conveyed to other flowers and other plants, and applied to their stigmas; and the cohesion of the packets of pollen, by their elastic threads, to the mass is so coördinated to the glutinosity of the stigma, as generally to ensure that the contents of the anther of one flower shall be distributed among the stigmas of several other and perhaps distant flowers, while it rarely, if ever, will reach its own. Here the closest hermaphroditism in structure subserves almost perfect diclinism in function.

We lose much in not having *Orchis pyramidalis* in this country; for its contrivances, as described by Mr. Darwin, are indeed exquisite. The figures that accompany Mr. Darwin's account render it very clear; without them a brief abstract may be hardly intelligible. The flower differs from that of other true Orchises in having two quite distinct oval stigmatic surfaces, separated by the pouch, which is here carried further downwards than usual, projecting into the nectary or spur a little below its orifice, which it partially closes. It is hollowed out on the under side in the middle, and the space is filled with fluid. The gland, or viscid disc, is single, in fact it answers to the two glands of an ordinary *Orchis* united into one, of the shape of a saddle, carrying on its flattish top or seat the stalks of the two pollen masses. "The disc is partially hidden and kept damp (which is of great importance) by the largely over-folded basal membranes of the two anther-cells. The upper membrane of the disc consists of several layers of minute cells, and is therefore rather thick. It is lined beneath with a layer of highly adhesive matter." When all is ready, if the lip of the pouch be depressed, for which the slightest touch suffices, "the under and viscid surface of the disc, still remaining in its proper place, is uncovered, and is almost certain to adhere to the touching object. Even a human hair, when pushed into the nectary, is stiff enough to depress the lip, or pouch, and the viscid surface of the saddle adheres to it. If, however, the lip be touched too slightly, it springs back, and re-covers the under side of the saddle."

"The perfect adaptation of the parts is well shown by cutting off the end of the nectary and inserting a bristle at that end, consequently in a reverse direction to that in which Nature intended moths to insert their proboscis, and it will be found that the rostellum (or pouch) may easily be torn or penetrated, but that the saddle is rarely or never caught. * * * Lastly, the labellum is furnished with two prominent ridges, sloping down to the middle and expanding outwards, like the mouth of a decoy. These ridges perfectly serve to guide any flexible body, like a fine bristle or hair, into the minute and rounded orifice of the nectary, which, small as it is, is partially choked up by the rostellum. This contrivance of the guiding ridges may be compared to the little instrument sometimes used for guiding a thread into the fine eye of a needle.

"Now, let us see how these parts act. Let a moth insert its proboscis (and we shall presently see how frequently the flowers are visited by Lepidoptera) between the guiding ridges of the labellum, or insert a fine bristle, and it is surely conducted to the minute orifice of the nectary, and can hardly fail to depress the lip of the rostellum. This being effected, the bristle comes into contact with the now naked and sticky under-surface of the suspended saddle-formed disc. When the bristle is removed, the saddle, with the attached pollinia, is removed. Almost instantly, as soon as the saddle is exposed to the air, a rapid movement takes place, and the two flaps curl inwards and embrace the bristle. When the pollinia are pulled out by their caudicles, by a pair of pincers, so that the saddle has nothing to clasp, I observed that the tips curled inwards, so as to touch each other in nine seconds, and in nine more seconds the saddle was converted, by curling still more inwards into an apparently solid ball. * * * Of course this rapid clasping movement helps to fix the saddle with its pollinia upright on the proboscis, which is very important; but the viscid matter, rapidly setting hard, would probably suffice for this end, and the real object gained is the divergence of the pollinia. These being attached to the flat top or seat of the saddle, project at first straight up, and are nearly parallel to each other; but as the flat top curls round the cylindrical and thin proboscis, or round a bristle, the pollinia necessarily diverge. As soon as the saddle has clasped the bristle and the pollinia have diverged, a second movement commences, which, like the last, is exclusively due to the contraction of the saddle-shaped disc of membrane. . . . . This second movement is the same as that in *O. mascula* and its allies, and causes the divergent pollinia, which at first projected at right angles to the needle or bristle, to sweep through nearly 90 degrees towards the tip of the needle, so as to become depressed, and finally to lie in the same plane with the needle. In three specimens this second movement was effected in from 30 to 34 seconds after the removal of the pollinia from the anther-cells, and, therefore, in about 15 seconds after the saddle had clasped the bristle.

"The use of this double movement becomes evident if a bristle with pollinia attached to it, which have diverged and become depressed, be pushed between the guiding ridges of the labellum into the nectary of the same or another flower; . . . . for the two ends of the pollinia will be found to have acquired [as the accompanying figures show] exactly such a position that the end of the one strikes against the stigma on the one side, and the end of the other, at the same moment, strikes against the stigma on the opposite side. These stigmas are so viscid, that they rupture the elastic threads by which the packets of pollen are bound together; and some dark green grains will be seen, even by the naked eye, remaining on the two white stigmatic surfaces. I have shown this little experiment to several persons, and all have expressed the liveliest admiration at the perfection of the contrivance by which this Orchid is fertilized.

"As in no other plant, or indeed in hardly any animal, can adaptations of one part to another, and of the whole to other organized beings widely remote in the scale of Nature, be named more perfect than those presented by this Orchis, it may be worth while briefly to sum them up. As the flowers are visited both by day and night-flying Lepidoptera, I do not think it is fanciful to believe that the bright purple tint (whether or not specially developed for this purpose) attracts the day-fliers, and the strong foxy odor the night-fliers. The upper sepal and the two upper petals form a hood, protecting the anther and the stigmatic surfaces from the weather. The labellum is developed into a long nectary, in order to attract Lepidotera; and we shall presently give reason for suspecting that the nectar is purposely so lodged that it can be sucked only slowly, in order to give time for the curious chemical quality of the viscid matter setting hard and dry. He who will insert a fine and flexible bristle into the expanded mouth of the sloping ridges on the labellum, will not doubt that they serve as guides, and that they effectually prevent the bristle or the proboscis from being inserted obliquely into the nectary. This circumstance is of manifest importance; for, if the proboscis were inserted obliquely, the saddle-shaped disc would become attached obliquely, and after the compounded movement of the pollinia they could not strike the two lateral stigmatic surfaces.

"Then we have the rostellum partially closing the mouth of the nectary, like a trap placed in a run for game; and the trap so complex and perfect, with the symmetrical lines of rupture forming the saddle-shaped disc above, and the lip of the pouch below; and lastly, this lip so easily depressed that the proboscis of a moth could hardly fail to uncover the viscid disk and adhere to it. But if this did fail to occur, the elastic lip would rise again and re-cover and keep damp the viscid surface. We see the viscid matter within the rostellum attached to the saddle-shaped disc alone, and surrounded by fluid, so that the viscid matter does not set hard till the disc is withdrawn. Then we have the upper surface of the saddle, with its attached caudicles, also kept damp within the basis of the anther-cells, until withdrawn, when the curious clasping movement instantly commences, causing the pollinia to diverge, followed by the movement of depression, which compounded movements together are exactly fitted to cause the ends of the two pollinia to strike the two stigmatic surfaces. These stigmatic surfaces are just sticky enough not to tear off the whole pollinium from the proboscis of the moth, but by rupturing the elastic threads to secure a few packets of pollen, leaving plenty for other flowers. But let it be observed that, although the moth probably takes a considerable time to suck the nectar of any one flower, yet the movement of depression in the pollinia does not commence (as I know by trial) until the pollinia are fairly withdrawn out of their cells; nor will the movement be completed, and the pollinia be fitted to strike the stigmatic surfaces, until about half a minute has elapsed, which will give ample time for the moth to fly to another plant, and thus effect a union between two distinct individuals."

Mr. Darwin subjoins a list of twenty-three species of Lepidoptera, to the proboscis of which the pollinia of *O. pyramidalis* have been found attached, four of them in more than one instance; a large majority carrying two or three pairs, one seven pairs, and another no less than eleven pairs, all invariably attached to the proboscis. A figure is given of the head and proboscis of an *Acontia*, bearing seven pairs of pollinia, attached one before the other, with perfect symmetry, as follows from the insertion of the proboscis having been guided by the ridges on the labellum; and he remarks that an unfortunate *Caradrina*, with its proboscis encumbered by eleven pairs, could hardly have reached the extremity of the nectary, and would soon have been starved to death. "These two moths must have sucked many more than the seven and eleven flowers, of which they bore the trophies; for the earlier attached pollinia had lost much of their pollen, showing that they had touched many viscid stigmas. * * * "In *O. pyramidalis* I have examined spikes, in which every single expanded flower had its pollinia removed. The 49 lower flowers of a spike from Folkstone (sent me by Sir Charles Lyell) actually produced 48 fine seed capsules; and of the 69 lower flowers in three other spikes, seven alone had failed to produce capsules." And pollen is often found on stigmas of flowers of Orchids which had not their own pollinia removed, while in others the pollinia had been carried away, but no pollen as yet left on their stigmas. "These facts show conclusively how well moths had performed their office of marriage priests."

Now, is it credible that all this admirable apparatus and these well-ensured and beneficial results are undesigned? On the supposition that *Orchis pyramidalis* was independently originated as it is, it would not be credible, nor would any one, probably, ever think of raising the question. Although supposable, would the absence of design be much less incredible, on the assumption that the Orchis we have been considering was the progeny (remote or near) of some ancestor which, like several existing Orchises, had the two viscid discs in close apposition, and *that* the progeny of another, which, like most species, had them distinctly separate? it being premised that both the ancestral forms were as perfect in their structure, and as well adapted to their surroundings, as the species with which we have compared them actually are. But we have no desire nor particular occasion to reopen this question now.

To return to our Orchids. The plan or general structure of the flower is the same in all the *Ophrydeæ;* but the particular contrivance varies from species to species, and from one genus to another. One British plant of the tribe, the *Bee Ophrys*,—so various are the resources of nature—differing in this respect even from its congeners, is adapted for self-fertillization, without insect aid. And the way in which the same Orchid-structure ordinarily adapted to insect coöperation, is made to do its own work, and do it well, assisted only by a breath of wind, is abundantly curious.

In the genus *Habenaria*, or *Platanthera*, the anther-cells are more separated and divergent, so that the glands or viscid discs are carried one to each side of the broad stigma, and there is no pouch; but the sticky disc, in some of our species, looking like a little pearl button, is perfectly naked; and when the flower-bud opens, stands directly in the way of the head of a moth or bee, thrusting its proboscis into the nectar-bearing spur. And here the viscidity of the disc, or gland, is beautifully adapted to that state of things. For, although fully exposed to the air, instead of setting hard at once, as in *Orchis*, the disc retains its viscidity during the whole period of anthesis, awaiting the coming of the insect, and quite sure to stick fast to the side of the face of the first one that dips its proboscis into the attractive nectary. The closest analogues we have of the British *Habenaria chlorantha*, so interestingly described by Mr. Darwin, are our *Platanthera orbiculata*, which is not yet in blossom, and *P. Hookeri*, upon which (as our delighted pupils may testify,) Mr. Darwin's details of the contrivance for the fertilization and pretty sure intercrossing of the individuals of the British species may be verified. It is a pretty experiment to bring the head of a butterfly or bee into the proper position, and to see how deftly the disc on each side attaches itself to the eye of the insect, making the animal carry off the pollinia upon withdrawal and migration to another blossom, —to see the pollinia turn inwards and downwards by a double movement, each of about 40 degrees, so that when now applied to the same or another flower, the pollinia no longer will strike against the anther-cells from which they were extracted, but against the broad stigmatic surface below and between. These movements of depression and rotation are best observed, and the intention demonstrated, by applying the tip of the finger or a small slip of glass to the gorge of the flower, so extracting the pollinia, and noticing that the latter, if immediately returned, would be applied to the cells from which they were taken, but that, after the lapse of a minute or less, they have so changed their direction, that now a return of the finger to the same place will pretty surely bring the pollen into contact with the stigma.

In two particulars our *P. Hookeri* differs most obviously from *Habenaria chloranthi*: its anther cells are still more widely divergent, and the labellum is incurved instead of being dependent. And these two particulars seem as if designedly correlated. The nectary of the British species, with hanging labellum, is most accessible by a direct front approach; and an insect whose face would touch and extract both of its pollinia, might, in that position, fail to hit either of the more widely separated discs of *P. Hookeri*. But while a moth of sufficient size would press down the labellum of the latter, using it as a landing place, and probably extract both pollinia at once, smaller insects would have to approach on one or the other side of it, and so be sure to hit one pollinium.

Our *Platanthera bracteata*, which is early flowering, serves completely to exemplify Mr. Darwin's account of the mechanism of *Peristylus viridis* (except as to the early pouch for the viscid discs, which the specimens brought us are too advanced to show, but which are likely to confirm the genus *Peristylus*); and the whole leaves scarce a doubt of the specific identity of the American and European plants, which botanists have strongly suspected.

Our Fringe Orchises and other Platantheras, blossoming later in the summer, will doubtless furnish interesting and varied illustrations of fertilization by insect aid; and we commend them, with Darwin's charming book as a guide, to all curious and interested observers. We have gone over two chapters only of this book, treating of one tribe of Orchids, and here we must drop it for the present, remarking that the five remaining chapters, so far as we have looked into them,—relating in part to tropical forms,—seem to be no less captivating than those which have give such new and surpassing interest to our most familiar Orchideous plants. A. G.

2. *Outlines of the Distribution of Arctic Plants*, with a map. By Jos. D. Hooker, M.D., F.R.S. (Extr. Linn. Trans., vol. xxiii, pp. 251-348. Read, June, 1860; issued, Oct. 1861.)

We have mentioned this important memoir already in the May number of this Journal, p. 404; have commented upon certain details as they came in the writer's way; and, in the concluding portion of the Report upon Dr. Parry's Rocky Mountain Collection, (which, from the press of other matter, is unavoidably deferred to the ensuing number,) other particulars and special botanical criticisms of this sort will find an appropriate place. Here, instead of such *minutiæ*, which only the systematic botanist could understand or care for, we wish to consider the general plan and character of a treatise upon which a vast amount of labor and knowledge has been lavished.

The immediate subjects of the treatise are the Arctic plants, of every phænogamous species known to occur spontaneously anywhere within the Arctic circle; the geographical distribution of which, so far as known, is carefully indicated: 1. Within the Arctic region, under the several divisions—Europe, Asia, W. America (Behring's Straits to the Mackenzie River), E. America (Mackenzie River to Baffin's Bay), and Arctic Greenland. 2. Without this circle, and under the general divisions of N. and Central European and N. Asiatic Distribution, with three longitudinal subdivisions; American Distribution, with appropriate subdivisions; S. European and African Distribution; Central and S. Asiatic Distribution. The theory upon which the facts are collocated and discussed, and which they are thought strongly to confirm, is that of Edward Forbes, which was completed, if not indeed originated by Darwin:—"first, that the existing Scandinavian flora is of great antiquity, and that previous to the glacial epoch it was more uniformly distributed over the Polar Zone than it is now; secondly, that during the advent of the glacial period this Scandinavian vegetation was driven southward in every longitude, and even across the tropics into the south temperate zone; and that, on the succeeding warmth of the present epoch, those species that survived both ascended the mountains of the warmer zones, and also returned northward, accompanied by aborigines of the countries they had invaded during their southern migration. Mr. Darwin shows how aptly such an explanation meets the difficulty of accounting for the restriction of so many American and Asiatic arctic types to their own peculiar longitudinal zones, and for what is a far greater difficulty, the representation of the same arctic genera by closely allied species in different longitudes. * * * Mr. Darwin's hypothesis accounts for many varieties of one plant being found in various alpine and arctic regions of the globe, by the competition into which their common ancestor was brought with the aborigines of the countries it invaded. Different races survived the struggle for life in different longitudes; and these races again, afterwards converging on the zone from which their ancestor started, present there a plexus of closely allied but more or less distinct varieties, or even species, whose geographical limits overlap, and whose members, very probably, occasionally breed together." A further advantage claimed for this hypothesis is, that it explains a fact brought out by Dr. Hooker in a former publication, viz.: "that the Scandinavian flora is present in every latitude of the globe, and is the only one that is so."

Moreover, Dr. Hooker discovers in the flora of Greenland a state of things explicable upon this hypothesis, but hardly by any other, viz.: its almost complete identity with that of Lapland; its general paucity, as well as its poverty in peculiar species; the rarity of American species there; the fewness of temperate plants in temperate Greenland; and the presence of a few of the rarest Greenland and Scandinavian species in enormously remote alpine localities of West America and the United States. Our author reasons thus: "If it be granted that the polar area was once occupied by the Scandinavian flora, and that the cold of the glacial epoch did drive this vegetation southwards, it is evident that the Greenland individuals, from being confined to a peninsula, would have been exposed to very different conditions from those of the great continents. In Greenland many species would, as it were, be driven into the sea, that is, exterminated; and the survivors would be confined to the southern portion of the peninsula, and, not being there brought into competition with other types, there could be no struggle for life amongst their progeny, and, consequently, no selection of better adapted varieties. On the return of heat survivors would simply travel northwards, unaccompanied by the plants of any other country."

The rustic denizens of Greenland, huddled upon the point of the peninsula during the long glacial cold, have never enjoyed the advantages of foreign travel; those of the adjacent continents on either side have 'seen the world,' and gained much improvement and diversity thereby. Considering the present frigid climate of Greenland, the isotherm of 32° just impinging upon its southern point, its moderate summer and low autumnal temperature, we should rather have supposed the complete extermination of the Greenland ante-glacial flora; and have referred the Scandinavian character of the existing flora (all but eleven of the 207 arctic species, and almost all those of temperate Greenland, being European plants,) directly to subsequent immigration from the eastern continent. Several geographical considerations, and the course of the currents, which Dr. Hooker brings to view on p. 270, would go far towards explaining why Greenland should have been re-peopled from the Old rather than from the New World. While the list (on p. 272, 273) of upwards of 230 Arctic-European species which are all likewise American plants, but are remarkable for their absence from Greenland, would indicate no small difficulty in the westward migration, and render it most probable that the diffusion of species from the Old world to the New was eastward through Asia, for the *arctic* no less than (as has elsewhere been shown) for the *temperate* plants. Was it that Greenland and the adjacent part of the American continent remained glacial longer than the rest of the zone? And if our northern regions were thus colonized by an ancient Scandinavian flora, this seems to have been in return for a still earlier donation of American plants to Europe, to which a very few existing but numerous fossil remains bear testimony. Speculative enquiries of this sort are enticing, and the time is approaching in which they may be fruitful.

Indeed, the characteristic features and the immediate interest and importance of the present memoir, as of others of the same general scope and interest, are found in this: 1. That the actual geographical distribution of species is something to be accounted for; 2. That our existing species, or their originals, are far more ancient than was formerly thought, mainly if not wholly antedating the glacial period; and, 3. That they have therefore been subject to grave climatic vicissitudes and changes. There may be many naturalists who still hesitate to accept these propositions, as there are one or two who deny them; but these or similar conclusions have evidently been reached by those botanists, paleontologists, and geologists in general who have most turned their thoughts to such enquiries, and who march foremost in the advancing movement of these sciences. In this position, the author of the present memoir—prepossessed with Darwin's theory of the diversification of species through natural selection—having occasion to revise systematically the materials of the arctic flora, is naturally led to compare the new theory with the facts of the case in this regard; to see how far the vicissitudes to which it is all but demonstrated that the plants of the northern hemisphere have long been subjected, and the modifications and extinctions which he thinks must have ensued under such grave changes and perils, during such lapse of time, may serve to explain the actual distribution of arctic species and the remarkable dispersion of many of them. That the enquiry is a legitimate and a hopeful one we must all agree, whether we favor Darwinian hypotheses or not. How well it works in the present trial we could not venture to pronounce without a far more critical examination than could now be undertaken. But there are good reasons for the opinion that this is just the ground upon which the elements of the new hypothesis figure to the best advantage.

The mass of facts, so patiently and skillfully collected and digested in this essay, have a high and positive value, irrespective of all theoretical views. We cannot undertake to offer an abstract, but may note here and there a point of interest. The flowering plants which have been collected within the arctic circle number 762, viz.: 214 Monocotyledons, and 548 Dicotyledons. They occupy a circumpolar belt of 10° to 14° of latitude. The only abrupt change in the vegetation anywhere along this belt is at Baffin's Bay, the opposite shores of which present, as has been already intimated, an almost purely European flora on the east coast, but a large admixture of purely American species on the west.

"Regarded as a whole, the artic flora is decidedly Scandinavian; for Arctic Scandinavia, or Lapland, though a very small tract of land, contains by far the richest arctic flora, amounting to three-fourths of the whole." This would not be very surprising, since this is much the least frigid portion of the zone, and has the highest summer temperature; but "upwards of three-fifths of the species, and almost all the genera of Arctic Asia and America are likewise Lapponian;" so that the Scandinavian character pervades the whole.

In the section on the local distribution of plants within the arctic circle, Dr. Hooker shows that there is no close relation discoverable between the isothermal lines (whether annual or monthly) and the amount of vegetation, beyond the general fact that the scantiness of the Siberian flora is associated with a great southern bend in Asia, and its richness in Lapland, with an equally great northern bend there, of the annual isotherm of 32°. Yet "the same isotherm bends northwards in passing from Eastern America to Greenland, the vegetation of which is the scantier of the two; and it passes to the northward of Iceland, which is mhch poorer in species than those parts of Lapland to the southward of which it passes." A glance at the supposed former state of things would suggest the explanation of all that is anomalous here.

"The June isothermals, as indicating the most effective temperatures in the arctic regions (when all vegetation is torpid for nine months, and excessively stimulated during the three others) might have been expected to indicate better the positions of the most luxuriant vegetation. But neither is this the case; for the June isothemal of 41°, which lies within the arctic zone in Asia, where the vegetation is scanty in the extreme, descends to lat. 54° in the meridian of Behring's Straits, where the flora is comparatively luxuriant." The aridity of the former, and the humidity of the latter district here offers an obvious explanation; also the great severity of the winter in the former, and its mildness in the latter. And Great Britain, in which a far greater diversity of species are capable of surviving without protection than in the Eastern United

States under the same annual isotherms, indicates the advantage of a mean over an extreme climate in this respect, if only there be a certain amount of summer heat. For lack of that, doubtless, very many of the introduced denizens of Britain would soon disappear, if deprived of human care.

"The northern limit to which vegetation extends varies in every longitude; the extreme is still unknown; it may, indeed, reach to the pole itself. Phœnogamic plants, however, are probably nowhere found far north of lat. 81°. Seventy flowering plants are found in Spitzbergen; and Sabine and Ross collected 9 on Walden Island, towards its northern extreme, but none on Ross's Islet, 15 miles further to the north."

"*Saxifraga oppositifolia* is probably the most ubiquitous, and may be considered the commonest and most arctic flowering plant." There are only eight or nine phænogamous species peculiar to the arctic zone, and only one peculiar genus, viz.: the grass, *Pleuropogon.** Of the 762 found south of the circle, all but 150 have advanced beyond lat. 40° N., in some part of the world; about 50 of them are identified as natives of the mountainous regions of the tropics, and 105 as inhabiting the south temperate zone.

"The proportion of species which have migrated southward in the Old and New World also bear a fair relation to the facilities for migration presented by the different continents." The tables given to illustrate this "present in a very striking point of view the fact of the Scandinavian flora being the most widely distributed over the world. The Mediterranean, South African, Malayan, Australian, and all the floras of the New World, have narrow ranges compared with the Scandinavian, and none of them form a prominent feature in any other continent than their own. But the Scandinavian not only girdles the globe in the arctic circle, and dominates over all others in the north temperate zone of the Old World, but intrudes conspicuously into every other temperate flora, whether in the northern or southern hemisphere, or on the Alps of tropical countries." * * * "In one respect this migration is most direct in the American meridian, where more arctic species reach the highest southern latitudes. This I have accounted for (Flora Antarctica, p. 230) by the continuous chain of the Andes having favored their southern dispersion."

In presenting the actual number of arctic species, and in delineating their geographical ranges, the question, what are to be regarded as species, becomes all important. As to this, it does not so much matter what scale is adopted, as to know clearly what the adopted scale is. Here we are not left in doubt. Taking European botanists by number, we are confident that nine out of ten would have enlarged the list of 762 phænogamous arctic species to 800 or more, and would not have recognized a goodly number of the synonyms adduced, thereby considerably affecting the assigned ranges, especially into temperate and austral latitudes. In this regard we should side with Dr. Hooker on the whole, but with differences and with questionings—with halting steps following his bold and free movement, but probably arriving at the same goal at length. Indeed, we freely receive the view which Dr. Hooker presents as appropriate to his particular purpose, and as the most useful expression of our knowledge of the relationships of the plants in question, when collocated in reference to the ideas upon which this memoir is based. That is: "if, with many botanists, we consider these closely allied varieties and species as derived by variation and natural selection from one parent form at a comparatively modern epoch, we may with advantage, for certain purposes,

* *Douglasia* is mentioned in another place (p. 269) as an absolutely peculiar arctic or arctic-alpine genus of E. America. But we have considered this genus as identical with *Gregoria*, of Duby. It would appear as if these two genera were established in the same year, since Lindley himself, in the Botanical Register, refers to Brande's Journal for January, 1828, for his original article. But this article will be found in the volume of that Journal for 1827; so that the name *Douglasia* is to be adopted, if the genus is sufficiently distinct from *Androsace*.

regard the aggregate distribution of such very closely allied species as that of one plant." "An empirical grouping of allied plants, for the purposes of distribution, may thus lead to a practical solution of difficulties in the classification and synonymy of species. My thus grouping names must not be regarded as a committal of myself to the opinion that the plants thus grouped are not to be held as distinct species. * * * My main object is to show the affinities of the polar plants, and I can best do this by keeping the specific idea comprehensive." And further: "I wish it then to be clearly understood, that the catalogue here appended is intended to include every species hitherto found within the arctic circle, together with those most closely allied forms which I believe to have branched off from one common parent within a comparatively recent geological epoch, and that immediately previous to the glacial period or since then" (p. 279). All we could ask more would be some distinction (typographical or other), to mark 1, undoubted and complete synonyms; 2, mere variations or states, local or otherwise, or undoubted varieties; 3, such as, theory apart, would claim to be regarded as distinct but closely related species. For example: to take one order, while *Rhinanthus minor* may well be considered as "not a sufficiently constant form to rank as a race even," while *Limosella tenuifolia* could rank for no more than a race, and while *Castilleia septentrionalis* and *C. pallida*, we are now convinced, however distinct in this single character, differ only (and inconstantly) in the relative development of the galea, we think it likely that *Pedicularis lanata*, Willd., does not rightfully merge in *P. hirsuta* this side of the glacial period, although it perhaps may into *P. Langsdorffii*, and that into *P. Sudetica*. But this is no place for criticisms upon the limitation of species, upon which the opinions of botanists will so greatly depend upon the amount of their materials, and upon which the best considered opinions must be subject to frequent revisal. Nor does the value of the present memoir at all depend upon the settlement of such points. To the philosophical naturalist, as to the archeologist, just now the most interesting and pregnant epoch of the world's natural history is that immediately antecedent to the present, that near past from which the present has proceeded, and upon which so much light, from very diverse sources, is now being concentrated: towards its elucidation the memoir we have been considering is a very valuable contribution. A. G.

3. *On the Cedars of Lebanon, Taurus, Algeria and India.* By J. D. HOOKER, M.D., F.R.S.

This paper, reprinted from the Natural History Review for January, 1862, (with 3 plates,) is one of the results of a visit to Mount Lebanon, in the autumn of 1860, upon the invitation of Capt. Washington, Hydrographer to the British Navy, for the purpose, among other things, of examining the famous Cedar Grove,—of which we have all heard so much and know so little. An interesting account is given of the grove and of the position it occupies, upon the floor of a basin, "crossed abruptly and transversely by a confused range of ancient moraines . . . . perhaps 80 to 100 feet high . . . . which have been deposited by glaciers that, under very different conditions of climate, once filled the basin above them, and communicated with the perpetual snow with which the whole summit of Lebanon was, at that time, deeply covered."

"The number of trees is about 400, and they are disposed in nine groups, corresponding with as many hummocks of the range of moraines; they are of various sizes, from about 18 inches to upwards of 40 feet in girth; but the most remarkable and significant fact connected with their size, and consequently with the age of the grove, is that there is no tree of less than 18 inches girth, and that we found no young trees, bushes, nor even seedlings of a second years growth. We had no means of estimating accurately the ages of the youngest or oldest tree: nor shall we have, till the specimens of the former arrive. It may be remarked, however, that the wood of the branch of the old tree, cut at the time, is eight inches in diameter (exclusive of bark), presents an extremely firm, compact, and close-grained texture, and has no less than 140 rings, which are so close in some parts that they cannot be counted without a lens. This specimen further, is both harder and browner than any English-grown Cedar or native Deodar, and is as odoriferous as the latter. These, however, are the characters of an old lower branch of a very old tree, and are no guide to the general character of the wood on the Lebanon, and still less to that of English-grown specimens, which are always very inferior in color, odor, grain, and texture. Calculating only from the rings in this branch, the youngest trees in Lebanon would average 100 years old, the oldest 2500, both estimates no doubt widely far from the mark. Calculating from trunks of English rapidly-grown specimens, their ages might be calculated as low respectively as 5 and 200 years; while from the rate of growth of the Chelsea Cedars, the youngest trees may be 22, and the oldest 6 to 800 years old.

"The positions of the oldest trees (of the 400) afforded some interesting data relative to the ages of the different parts of the grove, and the direction in which it had lately spread. There were only 15 trees above 15 feet in girth, and these all occurred in two of the nine clumps, which two contained 180 trees. Only two others exceeded 12 feet in girth, and these were found in immediately adjoining clumps, one on one side and one on the other of the above mentioned. There were five clumps containing 156 trees, none of which was above 12 feet in girth, and these were all to the westward, (or down-valley) side of the others. On this side, therefore, the latest addition to the grove has taken place.

"Whether the grove has much diminished within the historic period, is a question which can only be decided by a careful collection and scrutiny of the records of old travellers. It would not surprise me, if proofs existed of its not having materially decreased since the days of Solomon; for it is very doubtful whether the wood was ever largely used in Jerusalem for building purposes."

"On the other hand, that the grove has, within the historic period, increased and diminished in extent, owing to secular changes in the climate, cannot be doubted, when it is remembered, that no seedling has come to maturity (though thousands annually germinate), since the birth of trees the youngest of which is 18 inches in girth; and that the whole grove presents such a disparity in the ages of its trees, that only about 15 exceed as many feet in girth, and 385 fall below 12 feet girth. Upon this point I have collected some curious corroborative evidence, from the works of old travellers."

The Cedar also grows on the chain of the Taurus, 250 miles off. Fourteen hundred miles off in another direction, separated by the whole breadth of the Mediterranean sea, are the forests of *Cedrus Atlantica* of Algeria. "The African Cedar differs from that of Lebanon in having a perfectly erect, rigid leader, and stiff ends to the branches, all which, in the Lebanon plant, drop more or or less," and there are other but more variable differences. Fourteen hundred miles in the other direction reach to the borders of the Cedar forests of Affghanistan, which extend eastward almost to Nepal. The Himalayan Cedar, or Deodar, *C. Deodara*, "has a much more pendulous leader and end to its branches, and longer leaves, of a more glaucous hue than *C. Libani*, though not such silvery leaves as the *C. Atlantica*. The cones are as large as those of *C. Libani*, but the scales and seeds are of the same form as those of *C. Atlantica*, and hence markedly different from those of *C. libani*.

"From what has been said respecting each of these Cedars, it is evident, that the distinctions between them are so trifling, and so far within the proved limits of variation of Coniferous plants, that it may reasonably be assumed that all originally sprang from one. It should be added, that there are no other distinctions whatever between them—of bark, wood, leaves, male-cones, anthers, or the structure of these—nor in their mode of germination or duration, the girth they attain, or their hardiness. Also, that all are very variable in habit;

so much so, indeed, is this the case with the Deodar, which is the most distinct of all in habit, that though it was not introduced much more than thirty years ago, there are already five distinct varieties sold by nurserymen, some as stiff, others as dark-colored, and others as short-leaved as the Lebanon Cedar. Also, that though the difference in the shape of the scales and seeds of *Deodara* and *Libani* are very marked, they vary much; many forms of each overlap; and further transitions between the most disimilar, may be established by intercalation of seeds and scales from *C. Atlantica*."

"Hitherto, *C. Atlantica* has been almost universally considered a variety of *Libani* and *C. Deodara* a different specias; habit having been relied upon exclusively, and botanical characters neglected; for a glance at the drawings shows that there is an obvious and marked difference, in the latter respect, between the common states of *Atlantica* and *Libani*, and none between *Atlantica* and *Deodara*. This is perplexing, for, as I have said above, *C. Libani* holds an intermediate position, both geographically and in characters of foliage, between the two that agree in the most important characters; and further, we can account, in a great measure, for the differences of habit, by the climate of the three localities; the most sparse, weeping, long-leaved Cedar is from the most humid region, the Himalaya; whilst the plant of most rigid and otherwise opposite habit, corresponds with the climate of the country under the influence of the great Sahara desert. No course remains, then, but to regard all as species, or all as varieties, or the *Deodara* and *Atlantica* as varieties of one species, and *Libani* as another. The hitherto adopted and only alternative, of regarding *Libani* and *Atlantica* as varieties, and *Deodara* as a species, must be given up."

Dr. Hooker accordingly regards the three Cedars as three well-marked forms, usually very distinct, and so far permanent that, although of common origin, they will not revert again one to the other, or all to a common ancestral type. Upon his view, therefore, here are three forms, which, under variation, geographical segregation, and the suppression of intermediate states, have become fixed into what are generally called nearly related, representative species.

Finally he asks, how does it happen that they are now so sundered geographically? The answer to this question he derives from a consideration of the glacial period, when the Cedars of Lebanon must have been fully 4,000 feet lower than they are now, and continuous with those of Taurus, which also descended to the same lower level, and along the Persian mountains were connected with their Himalayan brethren, which also, upon the evidence of glaciers, must then have descended to fully 4,000 feet below their present level. The Algerian forests present more difficulty. For their solution the recent discoveries of extensive comparatively modern changes in the form and extent of the Mediterranean are confidently appealed to; the remains of the African Hippopotamus and Rhinoceros in Sicily so obviously indicating a continental extension from the Tunis coast to that Island, and the soundings lending corroboration to this view. If a forest thus extended at the glacial period will account for the diffusion of the Cedars, the succeeding warm period driving them northward and up the mountains, with the consequent extinctions, may well account for the present separation and for the present differences of the three surviving races.
A. G.

4. *Weddell's Chloris Andina* has advanced to the close of the second volume with the 16th *livraison*, issued Nov. 1861, thus finishing the Monopetalous and most of the Polypetalous orders. As to *Plantago*, while adopting and confirming Decaisne's hint that the species are vastly overdone in the Prodromus, Weddell has not sufficiently, if at all, recognized the diœcio-dimorphism which pervades the genus, and which in this country has long been understood. This, however, is most conspicuous in some groups of species which, not rising into the high Andes, are beyond the limits of his work.

Gaultheria, as Kalm, the founder of the genus, wrote the name, being dedicated to Dr. Gaulthier, it is a good idea of Weddell's to insert the missing vowel, thus by a slight change making the name of the genus, *Gaulthieria*, conform with that of the person commemorated. That it should have been so written in the first instance is clear enough; but it is doubtful if it be now worth while to change the original orthography, which is not far amiss. *Gaylusacia* is by no means peculiar to South America; Dr. Weddell must have casually overlooked the North American species.

The remark that the seeds afford characters by which the species of *Epilobium* may be distinguished, is worthy of attention. They do afford good characters in *Œnothera*.

We cannot agree with Dr. Weddell in restricting the genus *Malvastrum* to that marked group the *Phyllanthophora*. Thus restricted it would none the less rest upon a single character, and that one pertaining to the organs of vegetation; while a general view of the tribe will, we think, lead to the conclusion that the distinction between the styles with capitate stigma and those which are introrsely stigmatose is here well marked and well correlated with real affinities—that, in fact, *Malvastrum*, as a whole, and especially those species which are referred back by Weddell to *Malva*, are really more closely related to *Sida* and to *Sphæralcea* than to the genuine, old-world *Malva*.

The fact is overlooked that *Myosurus apetalus*, Gay, is often petaliferous, and occurs in North America.

Our remarks naturally run to criticisms of certain details. There can be no question that the Flora Andina is a work of a high order of merit. A. G.

ZOOLOGY.—

5. *Histoire Naturelle des Zoophytes Echinodermes.* . . . . par M. F. DUJARDIN et par M. H. HUSSÉ, Paris. Encyclopédie Roret. 1862.— It would naturally be supposed that a work on Echinoderms appearing in 1862 would advance in some degree our knowledge of that class; the more so as the authors had access to the Collections of the Jardin des Plantes and to the best libraries of Paris. The authors had at their disposal the original specimens of Lamarck and could have cleared up many doubtful points, and it was at least to be expected that this volume should be a faithful record of what had been done in the different orders of Echinoderms up to the time of publication. Instead of this it is a crude compilation of some of the most important works, made without any discrimination. The authors adopt or reject this or that classification at their pleasure without attempting to combine what there may be of truth in the different writers. The literature of later years seems to have escaped their notice entirely. Their ignorance of what has been done by American writers can hardly be excused on the ground of the difficulty of obtaining American publications in Europe. Wiegmann's Archiv which they quote so frequently contains in the excellent Reports of Prof. Luckart all that they needed to become acquainted with the papers of our American Naturalists on Crinoids, Starfishes, Echini and Holothurians. Their neglect is not confined to this side of the Atlantic, even the papers of Gray, of Peters, of Philippi are left unnoticed. It would be an endless task to enumerate the errors which have made this book a useless one, a needless addition to our overburdened scientific literature.

What confidence can we have in a compilation in which we are told that *Cidaris imperialis* Lam. is found in New Holland; that *Astropyga radiata* Gray, comes from South America and *Nucleolites recens* from the Antilles, although a few lines above we had been informed that the single living representative of the genus Nucleolites was found in New Holland,

and finally on page 541 *Echinometra Quoyi*, U. is said to be the young of *Podophora atrata* and on page 539 the same *Echinometra Quoyi*, U. is quoted as a species of the genus Echinometra!! What reliance can be placed in the characteristics of genera such as Leiocidaris in which we have given as generic, "Radioles en forme de longues baguettes sont toujours cylindriques et lisses," and on the next page we find as the specific character of *Leiocidaris* (Cidaris) *Thouarsii* "radioles subcylindriques très granuleux," *Cidaris hystrix* and *Cidaris papillata* are also referred to Leiocidaris though their spines are anything but "lisses" and "cylindriques." There is no uniformity in their nomenclature; we find for instance *Leiocidaris imperialis* Lam. immediatey below *Leiocidaris hystrix* Desor, for what reason we are not told. On one page the species is credited to the author who first described it, no matter to what genus it has been afterwards removed, while on the next page the opposite course will be followed and the species credited to the author who first placed it in its proper genus. The authors are equally unfortunate in their synonymic lists, these lists have been simply copied; they have not taken the trouble to compare their quotations: as for example in *Cidaris baculosa* the figures which are referred to in Savigny and the Revue et Magasin de Zoologie have nothing in common except that they have usually been quoted together by former writers. This is but a specimen of the manner in which this book has been manufactured, and the errors and contradictions which have been pointed out here are as numerous throughout the rest of the book as in the few genera we have so briefly examined. A. A.

IV. METEOROLOGY.

Meteorology.—Director WILLIAM HAIDINGER continues to give his particular attention to the investigation of Meteoric subjects, and has in several recent communications to the Imperial Academy of Vienna given information of new meteorites and meteoric phenomena, as well as additional particulars respecting some of those already mentioned in previous papers, of which we give the following abstracts:

(1.) (Meeting of June 20th, 1861.) The fall of the stone of Yatoor, near Nellore, in Hindostan, (the latter place at 14° 23′, N. L., and 80° 4′ E. of Greenwich,) took place at 4½, P. M., on January 23d, 1852, and was witnessed by three persons, who watched their herds in the neighborhood of the Choutoo Canal, east of the village Yatoor, in the Talook of Toumalatalpoor, and west of Yeruguntapollen.

They heard a single clap, similar to the report of a musket, then a somewhat rumbling noise. Looking in the direction of it, they saw, at a distance of about 20 fathoms, dust rising to the height of a man. Going thither they found in the ground, consisting of clay and sand, a hole of two spans wide and two spans deep, (15 to 16 inches,) and therein a *white* stone which was burst, and a fragment of which was carried away at once; the greater portion, however, was dug up on the following morning, by the "moonsiff" of the village. The total weight of the three pieces has been estimated at one mound =74⅔ lbs., avdps. The white color of the stone is very remarkable, since meteorites generally show a black crust.* The sky was perfectly clear and the air quiet;

* H. wrote on the margin of the copy of his paper, which he sent us: "*It had a black crust.*"

the report was so unexpected and surprising, that the herds were frightened and ran away. No phenomena of light were observed. Haidinger suggests that the fall took place perfectly vertically. This would give for the season and geographical latitude of Nellore of 14° 23′, N., about three days after the entrance of the sun into the sign of Aquarius, and for 4½ P. M., about in the direction south from Ophiuchus towards the earth; and the Yatoor stone can be considered as having come pretty nearly from this direction.

According to Dr. Andrew Scott, it contains silicic acid, alumina, magnesia, lime, sulphur, iron and nickel.

(2.) At the meeting of July 4th, 1861, he gave some additional information about the Parnallee meteorite, (this Journal, [2], xxxii, 442,) from observations made on a piece of 1 lb. 7½ loth, (= 691 grammes,) which had been sent to the Imperial Cabinet by Prof. Ch. A. Young, of Hudson, Ohio. It forms on one side an uneven fracture plane, of about 4½×3½ inches; about half of the other is covered with a crust, scarcely of $\frac{1}{20}$ of one line in thickness, of a brownish black color, and with but very little lustre. It shows the common roundish depressions, but remarkably enough, some only one half or even one quarter of an inch in diameter, and pretty steep; the direction of the motion of the whole meteorite cannot be determined therefrom. The whole piece is pretty flat.

Numerous pale gray, partly whitish portions, mostly quite roundish, imbedded through the mass, can be observed on a fracture; on polished planes the structure becomes more perceptible, a homogeneous matrix does not really exist, and a lens shows even the minutest portion to be a mixture of heterogeneous particles. Quite a numerous collection of various meteoric rocks would result if we could separate the larger fragments and rounded stones of this meteor, which it would be seen could have obtained their rounded form only in a previous condition. Whitish gray much-rounded fragments, up to ¼ of an inch in size, would pass for fragments of crystalline stones, similar to those of chladnite and piddingtonite of Chassigny and Shalka. The compact black ones, without lustre, of the same size, but remarkably angular, remind us of the peculiar Cold-Bokkeveld meteorites; then there are, in the mixture, metallic, compact or quite finely grained masses of an iron-pyrites of similar size, more angular in shape, and quite indifferent to the magnetic needle, hardly to be considered pyrrhotine, although their specific gravity, at 18° R., was = 4·520. Fine particles of metallic iron are also present, but in very small quantity, so that the specific gravity of the piece at 18° R. was = 3·175; yet the stone was porous, and continually giving out a stream of air bubbles, so that it may perhaps be above 3·2.

The most remarkable constituents, however, are certain much rounded yellowish or brownish particles, often yellow within and dark brown without, similar to those from l'Aigle, Chantonnay, Mentz, Segowlee, which on polished planes appear like being inclosed with brilliant metallic rings. But this inclosure is not produced by metallic iron, but by a substance like iron-pyrites. It shows but very isolated traces of incrustations by metallic iron, as in the meteorite of Assam, (this Journal, [2], xxx, 143,) and very characteristically in those of Serez and Renazzo. The incrustation of pyrites, however, must have taken place exactly in the same manner as that by metallic iron; the particles of matter—whatever may have been the agency required to dissolve the metallic iron, or a sulphid of it, and precipitate the same—were moveable and collected by moisture on the surface of the rounded fragments of rocks in the meteoric tufa, originating in the beginning from dust. In the larger masses of sulphid of iron are also minute particles of metallic iron.

On the whole, the Parnallee stone resembles the beautifully marbled stone of Assam and that of Chantonnay, but it is distinguished by its greater porosity and a less compact structure.

Dr. Andrew S. Scott mentions the following constituents as the result of a qualitative analysis: Silicic acid, alumina, ferric oxyd, magnesia, lime, iron, nickel, sulphur, and traces of cobalt and chrome.

(3.) At the meeting of October 17th, 1861, he made a communication regarding the meteorites of Montpreis, which fell July 31st, 1859. A letter of Mr. Mischitz, of Montpreis, to Prof. Suess, of Vienna, dated June 27th, contains the following data:

"Joseph Kozel, Francis Romich and myself observed the ball on July 31st, 1859, about 9½ P.M., when suddenly the sky towards north, in the direction of Paher, became illuminated, and the meteor moved from the north over the castle of Montpreis with a hissing noise down through the air, with the velocity of a shooting star, but larger in size and of more brilliancy, and fell right in front of the church of Montpreis and the wall of the churchyard, partly upon white sandstone, partly upon the solid gravelly soil. This fall produced a small excavation of scarcely the depth of half a nut-shell, burned the sandstone and soil as large as a silver dollar. All the fragments were visible in a glowing state, during 5 or 8 seconds, and when F. Romich picked one up he burned his fingers considerably, so that we were afraid to pick them up. A quarter of an hour later I picked up the pieces yet warm and three in number; the rest was like sand or street dust in the black-grey burned hole, and scattered over the similarly burned stone. All the pieces have, unfortunately, been lost. The fire of the mass was rather more yellowish than red. The fall, when touching the ground, was accompanied by a little clap, similar to that produced when rockets filled with star-fire, and yet burning, touch the surface of water. The pieces picked up looked like slags, with a thin black crust. Although nothing has been preserved of this fall, it is fully authenticated, and shows, besides, some important peculiarities.

It is particularly remarkable that the three pieces showed bright red heat a few seconds after their fall. They were certainly stone and not iron, or they would not have been broken into so many fragments, like sand and street dust. We have no records of high temperatures of stones; they are generally not warmer than if they had been lying in the sun, while on the other hand we have an example of the exceedingly cold and very large stone of Dhurmsala. The stone of Montpreis weighed scarcely more than 140 grammes. We might imagine that a small stone, especially if pretty well intermixed with metallic iron, could be thoroughly heated from the surface and become red hot, whilst the high temperature produced by the resistance of the air would not be sufficient to overcome the cosmical cold of the interior of a large stone, during the short time of its cosmical path through our atmosphere.

The stone appears not to have had much of a fireball, but simply to have been red hot, the only, and at that very insignificant, noise was produced by its striking the stone and soil, the surface of which it penetrated but very little, showing that it could not have come down with cosmical velocity.

The fall took place obliquely, in the direction from north to south, but much deviating from a vertical line.

The geographical situation of Montpreis is about 46° 7′ N. latitude, 15° 27′ E. of Greenwich. Adding the northern zenith distance of nearly 7° to the latitude, we obtain the altitude of 53°, from which the meteor descended. An astronomical map, set for July 31st, $9^h\ 30^m$, gives the position of the meteor at 270°, very nearly in the foot of Hercules, next to the head of the Dragon and Vega. The position of this region towards the earth is almost directly opposite to the translatoric motion of our solar system in space, which, according to Mädler, is 7 miles (German) per second. We might presume, therefore, that, as far as its position is concerned, the descending meteor remained stationary, or its approach was merely effected by the translatoric motion of our solar system. As to the motion of the earth in its position in space, between Aries and Taurus, we may assume the nearly conformable motion of 4·1 (German) miles per second. Thus the meteor would have descended on the ecliptic, probably from the neighborhood of the Balance, perhaps a real stranger to our solar system.

A communication of Dr. Kreil to Prof. Suess mentions several meteors, which were observed nearly on the same date:

At Kremsmünster, on the 29th, in S.S.E., a large fireball, with a bright luminous tail, which fell almost vertically towards the horizon. It lasted 3 to 4 seconds.

At Laibach, on the 29th, at $8^h\ 48^m$, a meteor in S.W. direction.

At Edelbach, near Montpreis, (in Lower Styria,) towards S.W., a fireball, followed by three shooting stars; much hissing, rumbling fall, but nothing was found.

At Neustadtl, (Krain,) a meteor, like that at Laibach.

(4.) At the meetings of October 17th and November 7th, 1861, he gave some additional information about the metallic iron masses from Cranbourne (near Melbourne, Victoria,) (this Journal, [2], xxxii, 441–443). The smaller mass, of about 3,000 lbs., is exhibited in Melbourne and intended to be sent to the World's Fair, which is to take place in London during this year.

The photographic view given represents it in its present position at Melbourne, which is the *reverse* of the original one. The following approximate measurements were sent by Dr. Neumayer, and refer to the block in its *original* position:

Viewed from	N.E. to S.W.	=3 ft. 1 in.,	S.E. to N.W.	=1 ft.	
"	" base,	=2 " 8 "	Op. "	= — 11 in.	
"	" N. Oc.	=1 " 1 "	St. "	=1 " 9 "	

The inner structure of the smaller piece could not well be determined from the few chips cut off with a chisel. Here and there was a wire-like structure visible, and richly disseminated through the whole mass, silver-white laminæ of schreibersite, showing but little lustre. No real crust was observed, but a pretty large coating of hydrated ferric oxyd, a proof of a very long period since its fall. In the well known roundish depressions was an hygroscopic substance, considered as containing ferrous chlorid. The sp. gr. found by Dr. Neumayer from 7·51 to 7·60; that of the coating, = 3·66.

Some of the chips, sent to Vienna, showed plainly, when sufficiently etched, the projecting edges of schreibersite; well polished plates, when exposed to heat, beautifully the pale yellow lines of schreibersite, in the darker violet and blue ground. An analysis, made by Karl von Hauer, gave:—very little insoluble residue, 95·43 p. c. of iron, and 3·40 p. c. of nickel, with a little cobalt.

The approximate measurements of the large, yet unmoved and apparently immovable mass make it in the direction of

N S	=	5 feet,	— inches.
db	=	3 "	1 "
gc	=	3 "	11 "

A part of the mass has been separated and partly worked up.

In a figure given in H.'s communication the mass is viewed from the north; the surrounding ground has partly been dug up; its probable height is estimated by Dr. Neumayer as not over 4 feet, the neutral plane towards magnetism being 1 ft. 10 in. below its upper limits, and 2 ft. 1 in. distant from its most southern point. Although the upper part is a strong north pole and the lower a south pole, numerous subordinate poles are distributed over the whole surface.

The positions of the two masses are given more accurately and completely than before. Their direction, in an astronomical line, is from S. 34° W. to N. 34° E.; their distance from each other 3·6 miles, (60 to 1° of the equator,) the smaller northerly of the larger. The geographical position of the smaller mass is 38° 8′ S. lat., and 145° 22′ E. of Greenwich; that of the larger, 38° 11′ S. lat., and 145° 20′ E. of Greenwich.

(5.) At the same meeting (Nov. 7th, 1861,) he mentions a magnificent meteor, observed by many persons in Southern Australia, on March 4th, 1861, at bright daylight, (9^h 38^m 5^s, Melbourne mean time,) of which Dr. Neumayer made a report to a Melbourne paper, computed from 26 observations. When first seen it was 50 miles above the ocean, and at a point of the ocean 30 miles from Cape Otway; it passed through the zenith; its diameter has been calculated at about 1,900 feet. From Neumayer's continued investigations (during the last 3 years) of shooting stars and meteors, it follows that this meteor came from a point of radiation in Perseus; whilst a meteor of extraordinary size, observed at Melbourne in August, 1858, came from the latter point and moved towards the former, so that both meteors had one and the same plane of motion; a fact which, if investigations were pursued, might throw some light upon this subject.

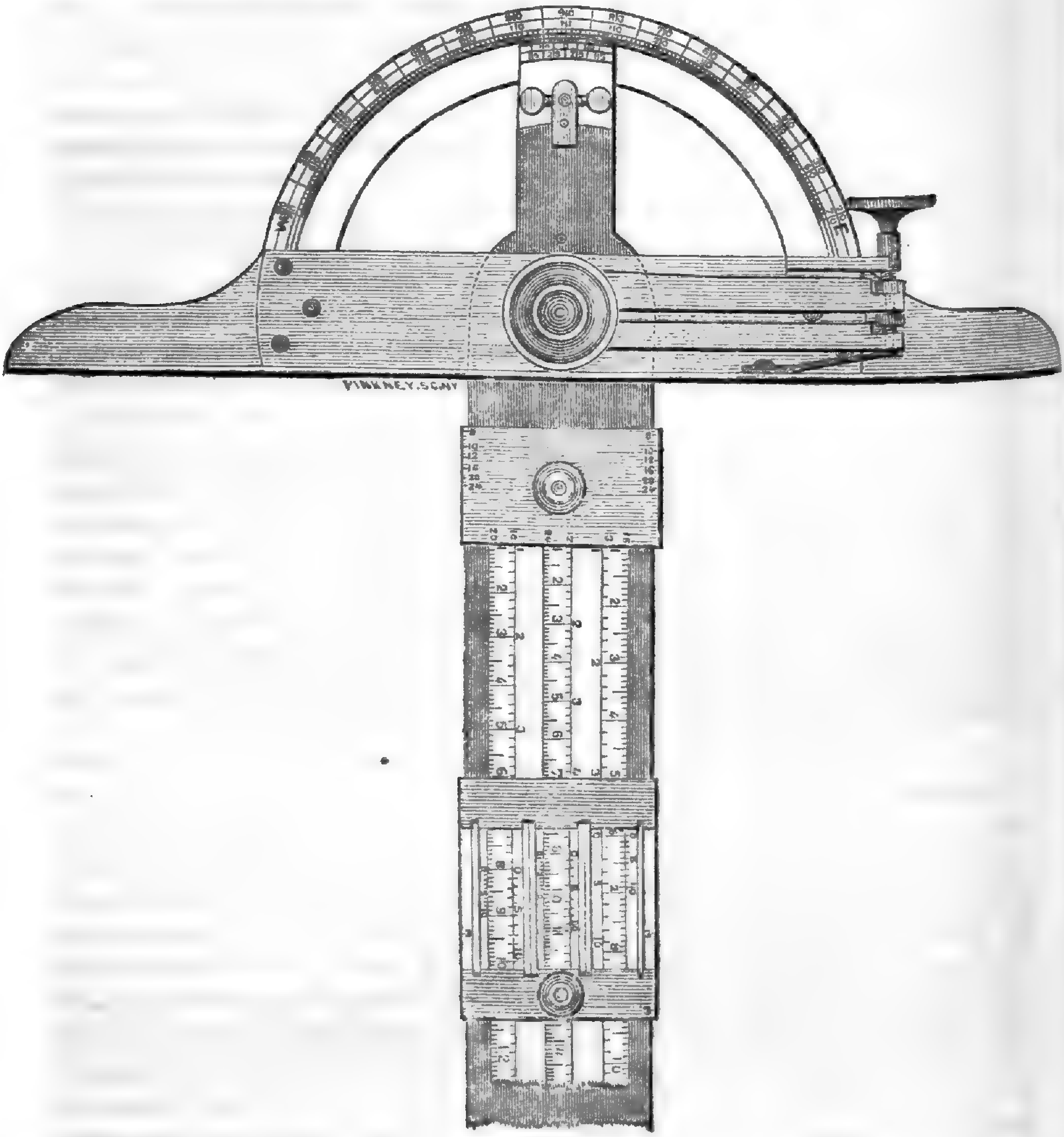
There are, according to Neumayer, other points of radiation for the southern hemisphere, and the periodical appearance of these celestial bodies does not coincide with that for the northern; there is no August period, but one in July and one in December. No observations could be made during the last three years in November, on account of the unfavorable state of the weather. F. A. Gth.

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *The California Geological and Natural History Survey.*—Good progress has been made in this important work, during the year and a half in which it has been in progress. We have received copies of a "Letter of the State Geologist relative to the progress of the State Geological Survey," addressed by Prof. Whitney, to the Governor of California, and dated December, 1861. This gives the organization of the Survey and and outline of the ground gone over in the first year's explorations, showing great industry, the area already explored being equal to at least one half the area of the State of New York. Forty-seven maps have been commenced on a scale of half an inch to a mile. The map of the region about San Francisco Bay comprising but a little corner of California (almost exactly the area however of the State of Connecticut) is nearly completed. The Topography of the State being so imperfectly known, a large amount of labor and expense falls on the Geological Survey in providing the Geographical elements essential to even a tolerably exact location of geological facts. Barometrical observations have been constantly kept up, and the data obtained for the determination of the elevation of about one hundred and fifty important points. Among others the Peak of Shasta about which such contradictory reports exist will be this summer the object of special barometrical examinations. Large collections of facts and specimens have been made in General Geology, Palæontology, Economical Geology, Botany, Agricultural Geology and Zoology. The preliminary Reports of the first and second year's work will be published in one volume, which may be expected by March, 1863. The law requires the Reports of the State Geologist to be sold for the benefit of the School Fund, which requirement prevents our using important geological information derived from the labors of the Survey, in advance of its publication. The appropriation made for the continuance of the Survey for the current year has been cut down to $15,000, one half the sum asked for by the Geologist-in-Chief (viz: $30,000), owing to the disturbed condition of the public finances and the sad disaster by the flood of last winter, which made wreck of a large part of the taxable property of the State. It is satisfactory to know that the floods have not been however, an unmixed evil, but that by their agency there is every prospect of a largely increased gold product this year. California is a vast region to explore, its area being twenty times that of Massachusetts, and equal to the united area of Great Britain, Ireland, Belgium, Hanover, and Bavaria. The work is laborious not more from the extent of surface, than from its heat, dust, chaparral and want of roads. It is proper to say that the Geological conclusions already reached, fixing the true age of the auriferous and other metallic deposits, and of the Coal, are of the greatest importance. The work for 1862 has been reduced in proportion to the diminished appropriation—the finances of the State being so deranged as to prevent even the prompt payment of the money appropriated. Prof. Whitney has wisely concentrated his remaining force upon the field work, determined to make the reconnaissance as complete as possible before the publication of the first volume of the report.

2. *Lyman's Trigonometer.*—Mr. Josiah Lyman of Lenox, Mass., has made a very valuable addition to our instruments for exact geometrical drawing. It consists in a happy combination of the protractor, straight

edge and scale of equal parts. It is to be used in connection with a draughting board which has its sides adjustable. The instrument is best understood from the cut. The long side of the semicircular protractor being placed against the edge of the draughting board, the steel ruler may be turned to make any required angle with the edge of the board. The angles are read by a vernier to minutes. A tangent screw and clamp afford facilities for small movements.



Upon the ruler slides a scale plate for measuring distances or for laying them down. There are six scales, representing divisions of the inch into 8, 10, 12, 16, 20 and 24 parts. Each has a vernier to tenths, and on most of them smaller parts may be estimated. The edges of the two parts of the sliding rule come down over the edge of the ruler to the surface of the paper, and fine marks on these edges make it easy to lay down accurately on the paper the distances indicated on the scales and verniers.

The instrument thus affords the means of plotting angles and distances with great accuracy and dispatch. The aim has been to make it possible to lay down angles to minutes, and distances to thousandths of an inch.

One great advantage of the instrument is, that it facilitates the computation of areas in land surveying. Anything which abridges the labor, of a process so frequently repeated, is of value. When the corners of a field have been plotted, the differences of latitude and the meridian distances can be measured, in a very short time, with an accuracy far greater than that ordinarily used in the field work of a survey.

No pains have been spared in the mechanical construction to make the instrument accurate. The methods of using it are fully detailed in an accompanying manual. This manual forms of itself, in fact, almost a complete treatise on land surveying.

3. *Donation of types of American Reptiles by the Smithsonian Institution to the Civico Museo of Milan.*—In the May number of this Journal we published a note from Prof. Henry, in reply to a statement, by our Paris correspondent, that the Smithsonian Institution, (excepting the British Museum,) was almost the only great establishment that had not contributed materials towards the work on serpents of Prof. Jan of Milan. In a recent article by Prof. Jan on the *Typhlopidæ*, in the Archivio per la Zoologia, etc., of Genoa, vol. i. p. 196, we find the following remarks:

"We have received from the Smithsonian Institution original specimens of nearly all the species (of serpents) described by Baird and Girard, and other American authors, and from the Museum of Philadelphia various types of Hallowell and Cope. Nearly all the specimens sent by the Museum of Washington are intended permanently to enrich our collection, thanks to the generosity of Dr. Henry, general Secretary of the Smithsonian Institution, and worthy interpreter of an establishment founded with the single object of promulgating and diffusing scientific knowledge, and of according to all those occupied in such pursuits, an efficient assistance and the most ample protection; an establishment, of its kind, not only rare but unique in the world."

OBITUARY.

Edward C. Herrick, died in New Haven his native place, June 11, 1862, aged 51 years. Mr. Herrick's name has been identified with the history of American science for a generation, and it was a household word to the readers of this Journal. Scarce a volume of which, since 1836, has been without some contributions from his pen. Mr. Herrick possessed an encyclopedic knowledge; his mind grasped with equal tenacity and accuracy a great variety of subjects rarely compassed by one individual. His first published memoir was a description of the Crustacean *Argulus catostomi* in connection with Prof. Dana. It is worthy of notice, in passing, that the first contributions to science published by three of those who have since been known as among our most constant and valued contributors, viz: Profs. Gray and Dana, and Mr. Herrick, appeared in the same number of our first series, viz: vol. xxxi, No. 2. Mr. Herrick's favorite study, in Zoology, was among insects. His researches into the history, habits and parasites of the Hessian Fly, (*Cecidomyia destructor* Say) are well known to entomologists. His principal published papers on this insect, appeared in 1841,(1) but his researches were continued, at intervals, through life. His last contribution to this Journal was on the seventeen-year locust, and a critical notice of the new edition of Harris's Insects injurious to vegetation.(2) But Mr. Herrick has been much

(1) This Journal, xli, 153. (2) [2], xxxiii, 433–434.

better known to our readers by his very numerous contributions to meterology and astronomy. He was one of the first to point out the existence of the August period of shooting stars,(3) his observatious having been published before reports of European discoveries had reached this country. Our knowledge of a shower in December and of one in April is mostly due to him. His catalogue of showers in past times,(4) which was the fruit of immense labor, was so complete that few undoubted instances have been added by those who have since labored in the same field.

For many years he was a constant observer of the Aurora Borealis, and by his zeal influenced many others to make similar observations. He first called attention to the frequent occurrence of this meteor in summer, at a time when the opinion was general that it was chiefly if not entirely confined to the winter months,(5) a subject vividly brought to his notice by a remarkable Aurora on the 1st of July, 1837(6).

Science, with Mr. Herrick, was only the recreation of a laborious life of business. Trained as a bookseller, and for a time conducting that business on his own account, he was in 1843 chosen Librarian of Yale College, and, in 1852, Treasurer of the same Institution, holding the latter office until his death. Mr. Herrick was eminent for his knowledge of books and precise memory of all that related to them. We copy the following from an appreciative notice of Mr. Herrick which appeared in the "Daily Journal," for June 12th, 1862:

"In that varied and miscellaneous knowledge which was congenial to a person of his comprehensive curiosity, his active habits, and his iron diligence, he had scarcely his equal in the University, and the extensive correspondence which he maintained for years with persons of varied pursuits, residing in every part of the country, and in Europe, is both an evidence that his knowledge was extensive and highly prized, and a monument to his industry and his disinterestedness. As a man of business, he was distinguished for quickness, sagacity, and the rarest integrity. The whole community knew him as one of the few in whom all might confide, and whom none could possibly suspect. His reputation in these respects was such as but few mortals attain or deserve.

As a friend he was affectionate and true—spending his services and his care for all that needed them, and often doing this with a lavish hand. Few men have cherished so sacredly, and have exemplified so perfectly, the saying of the Lord Jesus: "It is more blessed to give than to receive." His habits of life, interesting and peculiar as they were,—his genial severities, and his good-natured asceticisms,—his charming simplicity,—his delight in nature,—his generous readiness to serve his friends,—his kindness to the poor,—his genuine, yet never malignant, hatred of oppression, injustice and trickery,—his pining love for his mother, with many nameless traits, peculiar and unique, were wrought together into a character of rare interest to the friends who delighted in his society, and never ceased to wonder at the singular, yet not inharmonius, blending of traits appropriate to Socrates and the Apostle John."

It was in harmony with his deep modesty of character that he ordered that his funeral should be private, and that no eulogy upon his life should be pronounced.

(3) This Journal, [1], xxxiii, 176, 354, 401. (4) [1], xxxv, 366, xl, 349, 365, xxxix, 334, xliii, 201, 398. (5) [1], xxxiii, 259. (6) xxxiii, 143.

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[SECOND SERIES.]

Art. XVI.—*On the Ancient Lake Habitations of Switzerland;* by John Lubbock, Esq., F.R.S.*

[The interest attached to the subject of Mr. Lubbock's memoir warrants its republication, as but few American readers have access to the original. M. Morlot, whose researches are alluded to in this article, will be well remembered by the readers of this Journal from his paper entitled 'General views on Archæology,' published in vol. xxix.]

Archæology forms the link between Geology and History—the past and the present. If in its more recent portions it is scarcely distinguishable from History, yet when we pass back to its commencement, we find ourselves to have imperceptibly glided into the domain of Geology, without noticing any boundary to separate the one from the other. The begining of Archæology being, in fact, but the end of Geology, it is not surprising that they should, in the course of their development, have presented some remarkable analogies. M. Morlot has well pointed these out in his "Leçon d'ouverture d'un cours sur la haute antiquité, fait a l'Academie de Lausanne."

Even, indeed, as the remains of extinct animals were at first supposed to be few and far between, whereas, in fact, the surface of the earth is made up of the dust and skeletons of our predecessors, so the relics of man, long looked upon as rare and exceptional in their occurrence, are gradually presenting themselves in unexpected profusion. Loth, however, to distrust the existing

* From the Natural History Review for January, 1862, p. 26.

chronology, our antiquaries long referred all the most beautiful and well made weapons to the Romans, just as all fossils were attributed to the action of the deluge. Passing on, then, with a graceful compliment to the two of our most eminent contemporaries, M. Morlot points out that as Lyell, the reformer of Zoology, by studying the changes now taking place on the earth's surface, has explained the results which Geology brings before us, and thus arguing from the known to the unknown, has used the Present as a key to unlock the Past; so M. Thomson, by collecting the implements and recording the habits of the existing savages, has thrown much light upon the manners and customs of ancient times. Fully recognizing the imperfection of the record in the one case as well as in the other, we must guard ourselves against any hasty conclusions and generalizations but it seems now to be well established that a considerable elongation of the received chronology is required in Archæology as decidedly, though not of course to such an extent, as in Geology.

Perhaps, also, we may regard it as, to say the least, highly probable, that in Northern Europe there have been three great epochs in the history of man—primary, secondary, and tertiary —the first of Stone, the second of Bronze,* and the third of Iron. This conclusion, which we owe in the first instance to the Northern and especially to the Danish Archæologists, has been much strengthened by the recent researches in the lakes of Switzerland.

It is however probable, as was mentioned in our last number, that the Stone period will require much sub-division. In all classifications we are apt, at first, to take the apparent, for the real dimensions of the more distant portions, and it is only as we obtain a closer acquaintance with them, that we discover their real proportions. Thus, it would appear, that the Stone age must be divided into at least two periods; that of the drift on the one hand, and on the other hand, that to which the Danish Kjökkenmöddings and the Swiss Lake Habitations appear to belong.

These Lake-dwellings or "Pfahlbauten,"—a term whose nearest English equivalent is "Pile-works"—were made known to us in the following manner.

In consequence of the extraordinary dryness and coldness of the weather during the winter months of 1853 and 1854, the rivers of Switzerland did not receive their usual supplies, and the

* In a grave at Mare Hill in Staffordshire, Mr. Carrington found "a piece of lead," having the appearance of wire, which subsequent researches prove to have "been accidentally fused from metalliferous gravel present upon the spot." May not copper have been first obtained from some bright piece of ore, used as an ornament, and burnt with its wearer? The coincidence of a knowledge of metal with the practice of burning the dead is at least significant.

The copper of North American tumuli is plainly traced to the deposits of native copper near Lake Superior.—EDS.

water in the lakes fell much below its ordinary level, so that in some places a broad strand was left uncovered along the margin, while in others shallow banks were converted into islands. The water level of this season was, indeed, the lowest upon record. The lowest level marked on the so-called stone of Stäfa was that of 1674, but in 1854 the water sank a foot lower. These unusual conditions, though very unfavorable to navigation, enabled the Swiss Archæologists to make the important discoveries which we are about to bring before our readers.

M. Aeppli of Meilen, on the Lake of Zurich, appears to have been the first to observe, in the bed of the lake, certain indications of human activity, which he justly supposed might throw some light on the history and condition of the earliest inhabitants of the Swiss valleys. In a small bay between Ober Meilen and Dollikon, the inhabitants took advantage of the lowness of the water to increase their gardens, by building a wall along the new water-line, and slightly raising the level of the piece thus reclaimed, by mud dredged from the lake. In the course of this dredging they found great numbers of piles, of deer horns, and also some implements. The researches at this place conducted and described by Dr. F. Keller, have been followed by similar investigations in other lakes, and have proved that the early inhabitants of Switzerland constructed some, at least, of their dwellings above the surface of the water, as is done in the present day by savages in various countries, as for instance the Papous of New Guinea, whose huts, circular or square in form, are grouped on wooden platforms, elevated a few feet above the level of the water, supported by numerous piles driven into the mud, and connected with the land by a narrow ridge.

This method of construction, indications of which are found in various parts of Europe, was especially mentioned by Herodotus,* who describes the Pœonians of Lake Prasias, in Thrace, as living in cabins situated on a platform, supported above the water by great piles. Each cabin had a trap-door opening on to the lake, and the whole settlement communicated with the main land by a bridge.

The Swiss "*Pfahlbauten*," or lake habitations, have been described by M. Keller, in three memoirs presented to the Antiquarian Society of Zurich, in 1854, 1858, and 1860, and by M. Troyon, in a special work, "Sur les Habitation Lacustres," 1860, in which the author gives a general account of what has been done in Switzerland, and compares the result obtained in his native land, with the lake dwellings of other countries and times. The discoveries in Lake Moosseedorf have been described in a special paper by MM. Jahn and Uhlmann (Die Pfahlbaualterthumer von Moosseedorf. Bern, 1857); and we owe to M.

* Her. Book V, ch. 16.

Rütimeyer to works on the animal remains from the Pfahlbauten the first "Untersuchung der Thierreste aus den Pfahlbauten der Schweiz," published by the Antiquarian Society of Zurich, in 1860; and still more recently a larger work*—Collections of objects from these localities have also been made by many Swiss Archæologists.

The Flora has been studied by M. Heer, whose results are contained in the last memoir published by M. Keller. Nor must we omit to mention M. Morlot's short paper in the "Bulletin de la Societe Vaudoise," and his more recent "Leçon d'Ouverture d'un cours sur la haute Antiquité fait a l'Académie de Lausanne." From the conclusion of this lecture, indeed, I must express my dissent: not that I would undervalue what M. Morlot calls the Practical Utility of Geology, nor that I am less sanguine as to the future advantages of Archæology. Science, however, is like virtue, its own reward, and the improvement of the mind must be regarded as the highest object of study. However this may be, M. Morlot is, to use his own metaphor, laboring earnestly in the vineyard, and is improving the soil, though, as in the old fable, it may be in the false hopes of finding a concealed treasure. The Swiss Archæologists have, indeed, made the most of a golden opportunity, Not only in Lake Zurich, but also in Lakes Constance, Geneva, Neufchatel, Bienne, Morat, Sempach, in fact in most of the large Swiss lakes, as well as in several of the smaller ones (Inkwyl, Pfaffikon, Moosseedorf, Luissel), similar lake habitations have been discovered. In the larger lakes, indeed, not one, but many of these settlements existed; thus, M. Keller mentions, in Lake Bienne, eleven; in Lake Neufchatel, twenty-six; in the Lake of Geneva, twenty-four; in that of Constance, sixteen; and many more, doubtless, remain to be discovered.

The dwellings of the Gauls are described as having been circular huts, built of wood and lined with mud. The huts of the Pileworks were probably of a similar nature. This supposition is not a mere hypothesis, but is confirmed by the preservation of pieces of the clay used for the lining. Their preservation is evidently due to the building having been destroyed by fire, which has hardened the clay and enabled it to resist the dissolving action of the water. These fragments bear, on one side, the marks of interlaced branches, while on the other, which apparently formed the inner wall of the cabin, they are quite smooth. Some of those which have been found at Wangen are so large and so regular that the Swiss Archæologists feel justified in concluding that the cabins were circular, and from ten to fifteen feet in diameter. Though, therefore, the architecture of this period was

* Die Fauna der Pfahlbauten in der Schweiz. Untersuchungen über die Geschichte der wilden und der Haus Saügathieve von Mittel Europe von Dr. L. Rütimeyer. This work contains a full resumé of the subject up to the present time.

very simple, still the weight to be sustained on the wooden platforms must have been considerable, and their construction, which must have required no small labor,* indicates a considerable population. It would, indeed, be most interesting if we could construct a retrospective census for these early periods, and M. Troyon has made an attempt to do so, though the results must naturally, be somewhat vague. The settlement at Morges, which is one of the largest in the Lake of Geneva, is 1200 feet long and 150 broad, which would give a surface of 180,000 square feet. Taking the cabins as being 15 feet in diameter, and supposing that they occupied half the surface, leaving the rest for gangways, we may estimate the number of cabins at 311, and if we suppose that, on an average, each was inhabited by four persons, we shall have, for the whole, a population of 1244. Starting from the same data, we should obtain for the Lake of Neufchatel, a population of about 5000. Altogether, 68 villages, belonging to the Bronze Age, have been discovered in Western Switzerland, and by the same process of reasoning they may be supposed to have contained 42,500 persons; while for the preceding epoch, the population may, in the same manner, be estimated at 31,875.

For a moment it may surprise us that a people so uncivilized should have constructed their dwellings with immense labor on the water, when it would have been so much more easy to have built them on dry land. The first settlers in Switzerland, however, had to contend with the Boar, the Wolf, the Bear, and the Urus; and subsequently, when the population increased, and disputes arose, the lake habitations, no doubt, acted as a fortification, and protected man from man, as they had before preserved him from wild beasts.

Switzerland is not, by any means, the only country in which lake dwellings have been used as fortresses. In Ireland, a number of more or less artificial islands, called "Crannoges,"† are known historically, to have been used as strongholds by the petty chiefs. They are composed of earth and stones, strengthened by numerous piles, and have supplied the Irish Archæologists with numerous weapons and bones. From the Crannoge at Dunshuglin, indeed, more than 150 cart loads of bones were obtained, and were used as manure! These lake dwellings of Ireland, however, come down to a much later period than those of Switzerland, and are frequently mentioned in early history. Thus, according to Shirely, "One Thomas Phelliplace, in his answer to an inquiry from the Government, as to what castles or forts O'Neil hath, and of what strength they be, states (May

* "Increasing density of population is equivalent to increasing facility of production." Bastiat, Harmonies of Political Œconomy, p. 12.

† See Wilde's Catalogue, vol. i, p. 220.

18, 1567): 'For castles, I think it be not unknown unto your honors, he trusteth no point thereunto for his safety, as appeareth by the raising of the strongest castles of all his countreys, and that fortification that he only dependeth upon is *in sartin ffresh-water loghes* in his country, which from the sea there come neither ship nor boat to approach them: it is thought that there in the said fortified islands lyeth all his plate, which is much, and money, prisoners and gages: which islands hath in wars to fore been attempted, and now of late again by the Lord Deputy there, Sir Harry Sydney, which for want of means for safe conducts upon the water it hath not prevailed.'"

Again, the map of the escheated territories, made for the Government, A. D. 1591, by Francis Jobson, or the "Platt of the County of Monaghan," preserved in the State Paper Office, contains rough sketches of the dwellings of the petty chiefs of Monaghan, which "are in all cases surrounded by water."* In the "Annals of the Four Masters," and other records of early Irish history, we meet with numerous instances in which the Crannoges are mentioned, and some in which their position has not preserved them from robbery and destruction; so that we need not be surprised to find that most of the Swiss Lake habitations appear to have been destroyed by fire. Though, however, these latter resemble the Irish Crannoges in their position and use, they differ considerably from them in their construction. In one or two places, indeed, as for instance at the Steinberg, in the Lake of Bienne, it is possible that an island may have been formed, the bottom of the lake having been artificially raised. It is curious that a canoe laden with stones, was actually found near this spot, it having, apparently, sunk with its load, at the time when the Steinberg was in process of construction. After all, however, it seems probable that even in this case, the object was only to obtain a firmer foundation for the piles. At the present time the highest part is eight feet below the surface of the water, and nothing justifies us in looking back to any such alteration of level. Moreover, even now the piles project two or three feet above the surface, upon which, therefore, the cabins cannot have been intended to stand. A small island in Lake Inkwyl, however, reproduces almost exactly the Irish Crannoge.

After having chosen a favorable situation, the first step in the construction of the Lake habitations was to obtain the necessary timber. To cut down a tree with a stone hatchet must have been no slight undertaking. It is, indeed, most probable that they made use of fire, in the same manner as is done by existing savages in felling trees and making canoes. Burning the wood and then scraping away the charred portion, renders, indeed the task far more easy, and the men of the Stone period appear to

* Ibid. p. 231.

have avoided the use of large trees, except in making their canoes. Their piles were imbedded in the mud for from one to five feet, and must also have projected from four to six feet above the water level, which cannot have been very different from at present. They must, therefore, have had a length of from 15 to 30 feet, and they were from 3 to 9 inches in diameter. The pointed extremity which entered into the mud still bears the marks of the fire, and the rude cuts made by the stone hatchets. The piles belonging to the Bronze period being prepared with metal axes, were much more regularly pointed, and the differences between the two have been ingeniously compared to those shown by lead pencils well and badly cut. Draging the piles to the lake, and fixing them firmly, must have required much labor, especially when their number is considered. At Wangen alone M. Lohle has calculated that 40,000 piles have been used; but we must remember that these were probably not all planted at one time, nor by one generation. Wangen, indeed, was certainly not built in a day, but was, no doubt, gradually added to as the population increased. Herodotus informs us that the Pœonians made the first platform at the public expense, but that subsequently at every marriage (and polygamy was permitted), the bridegroom was expected to add a certain number of piles to the common support. In some localities, as at Robenhausen, on Lake Pfeffikon, the piles were strengthened by cross beams. The Pileworks of subsequent periods differ little from those of the Stone age, except, perhaps, that they are more solidly constructed. The piles, also, are less decayed and project above the mud farther than those of the preceeding epoch. M. Morlot considers that the horizontal platform rested upon the top of these piles, at such a height as to allow for all ordinary variations in the level of the water. M. Suter, however, supposes that in some cases, at least, the platform was not attached to the perpendicular piles, but rested upon the water, rising and sinking with it. The structure of the Pileworks at Wauwyl, in the Canton of Lucerne, certainly seems to favor this view: It was composed of four rectangular divisions, separated by narrow channels, over which, no doubt, bridges were thrown, and through which canoes might pass. The piles were less numerous than usual, and were grouped principally around the outer edge of the platforms. In this case they have been preserved by peat; they are from three to four and a half inches in diameter, all rounded, and not formed of split timber. In order to ascertain their length, M. Suter dug up two of them; the longest penetrated four feet through the peat, and ten feet six inches into the ancient bed of the lake; the other, also four feet through the peat, but only four feet six inches lower. M. Suter examined the piles carefully, but fruitlessly, to ascertain any manner in which the platform can have been attached to them.

The platform itself consisted of five layers of trees, curiously and carefully fastened together by clay and interlaced branches of trees, but like the perpendicular piles they were examined in vain for any traces of notches, mortises, holes, ligatures, bolts, or any contrivance, by which the upright piles and the platforms could have been fastened together.

Not only were the debris of their repast, and other rubbish thrown into the water, but more or less valuable weapons and instruments must have been sometimes lost in this manner, especially as children formed, of course, the usual proportion of the population. Many of the articles presently to be mentioned, were however, in all probability, engulphed at the destruction of the Pfahlbauten, some of which were perhaps burnt and rebuilt more than once.

The number of stone implements which have been already found is quite astonishing; at Wangen, in Lake Constance, many hundred weapons of various sorts have been discovered, and a great number also at Moosseedorf, Wauwyl and Robenhausen, in none of which places has a single piece of metal been as yet met with, a fact which, taken in connection with the great number of bronze implements which have been collected from other Pileworks, clearly indicates that the settlements above mentioned belonged to the age of Stone. Not only, however, is metal absent, and not only, as we have already seen, does the Fauna indicate a greater antiquity, but the stone weapons themselves are less varied and less skillfully made. Most of them are made from rocks which occur in Switzerland, though it is probable that the flint was brought from France. The absence of any great blocks of this valuable material in Switzerland accounts for our not finding any of the large, flat axes which are so characteristic of northern Europe, and especially of Denmark. At Wangen, the stone implements resemble those of Moosseedorf, and are principally formed of indigenous rocks, which to judge from the fragments scattered about, were evidently worked up at these two places. One or two bits, however, consisted of Oriental nephrite, which is green, transparent, and of remarkable hardness, and if these really belonged to the Stone age, the fact is very remarkable, as this substance, according to Swiss mineralogists, does not naturally occur in Switzerland, and must have been brought from Egypt or Asia. On this point, however, it would be desirable to have more information; since, if we are to suppose that any such extended commerce existed, it is difficult to understand why bronze and iron were not also introduced. Weapons of nephrite have also been found at one or two other places, belonging to the Bronze age, and where therefore its presence is less inexplicable. The stone impliments found in the settlements belonging to this earliest period consists of hammers, axes, knives, saws, lance heads, arrow heads, corn crushers, and polishing blocks. Some of the hammers were made of serpentine with a hole pierced through one end, and are, like all pierced stones, of very great rarity, belonging perhaps only to the end of the Stone period. Some of them are cylindrical, others more cubical in shape.

The axe was preëminently *the* implement of antiquity. It was used in war and in the chase, as well as for domestic purposes, and great numbers have been found, especially at Wangen, (Lake of Constance) and Concise (Lake of Neufchatel). With a few exceptions they were surprisingly small, especially when compared with the magnificent specimens from Denmark; in length they varied from six inches down even as low as one, while the cutting edge had generally a width of from 15 to 20 lines. Flint was sometimes used, and nephrite, or jade, in a few cases, but serpentine was the principal material. Most of the larger settlements were evidently manufacturing places, and many spoilt pieces and half finished specimens have been found. The process of manufacture is thus described by M. Troyon. After having chosen a stone, the first step was to reduce it by blows with a hammer to a suitable size. Then grooves were made artificially, which must have been a very tedious and difficult operation, when flint knives, sand, a little water, and an unlimited amount of patience, were the only available instruments. Having carried the gooves to the required depths, the projecting portions were removed by a skillful blow with a hammer, and the implement was then sharpened and polished on blocks of sandstone.

Sometimes the hatchet thus obtained was simply fixed in a handle of horn or wood. Generally, however, the whole instrument consisted of three parts. A piece of horn, two or three inches in length, received the stone at one end and was squared at the other, so as to fit into a longer handle either of wood or horn. These intermediate pieces present several variations, some are simply squared, others have a projecting wing which rested against the handle, some few are forked as if to receive a wedge, and one had a small transverse hole apparently for the insertion of a peg.

The knives may be considered as of two sorts. Some differ from the axes, principally in having their width greater than their length. In other cases they were made of flint flakes. In this manner also were obtained the saws, which in addition had their edges somewhat rudely dentated; they were fixed into handles of wood by some sort of cement; but we do not find in Switzerland any of the semilunar saws, which are frequent in Denmark.

The arrow heads were made of flint, or in some cases of rock crystal, and were, as in Ireland, of three principal sorts, between which however, there were a great many varieties. The first sort had a diamond shape, the posterior half of which was, in some specimens, shorter and rounded off. The second sort had the posterior margin more or less excavated, so that the angles being produced, as it were, into wings, clasped the shaft and enabled the arrow head to be more firmly fixed. In the third sort, the middle part of the posterior side had a projection which sunk into the shaft. There are also found rounded stones, pierced with one, or sometimes with two holes. The use of these is uncertain, but they may perhaps have been used to sink fishing lines.

"Waste not, want not," is a proverb which the Lake dwellers thoroughly appreciated. Having caught any wild animal, except the hare, they ate the flesh, used the skin for clothing, picked every fragment of marrow out of the bones, and then in many cases, fashioned the bones themselves into weapons. The larger and more compact ones served as hammers, and, as well as horns of the deer, were used for the handles of hatchets. In some cases pieces of bone were worked to a sharp edge, but they can only have been used to cut soft substances.* Bone harpoons, poignards, arrow heads, and javaline heads also occur, and pins and needles of this material are very common. Teeth also, and particularly those of the wild boar, were used for cutting, and were also, in some cases, worn as ornaments or armlets. There can be little doubt that wood was also extensively used for different purposes, but unfortunately most of the implements of this material have perished. A wooden mallet, however, was found at Concise.

For our knowledge of the animal remains from the Pileworks we are almost entirely indebted to Prof. Rütimeyer, who has published two memoirs on the subject. (Mittheilungen des Antiq. Gesellschaft in Zurich, Bd. xiii, Abth. 2, 1860; and, more recently, a separate work, Die Fauna des Pfahlbauten in der Schweiz, 1861). The bones are in the same fragmentary condition as those from the Kjökkenmöddings, and have been opened in the same manner for the sake of the marrow. There is also the same absence of certain bones and parts of bones, so that it is impossible to reconstruct a perfect skeleton even of the commonest animals.

The total number of species amounts to about 66, of which 10 are fishes, 3 reptiles, 17 birds, and the remainder quadrupeds. Of the latter, eight species may be considered as having been domesticated, namely, the Dog, Pig, Horse, Ass, Goat, Sheep,

* According to Sir E. Belcher, however, sharpened pieces of horn are used by the Esquimaux in the preparation of flint weapons.

and at least two species of Oxen. The bones very seldom occur in a natural condition, but those of domestic and wild animals are mixed together, and the state in which they are found, the marks of knives upon them, and their having been almost always broken open for the sake of the marrow, are all evidences of human interference.

Two species, the one wild, the other domestic, are especially numerous,—the Stag and the Ox. The remains of these two indeed equal those of all others together. It is, however, interesting, that in the older settlements, as Moosseedorf, Wauwyl, and Robenhausen, (Lake Pfeffikon,) the Stag exceeds the Ox in number of specimens indicated, while the reverse is the case in the more modern settlements of the western lakes, as, for instance, those at Wangen and Meilen.

Next to those in order of abundance is the Hog. More sparing again, and generally represented by single specimens where the preceding occur by dozens, are the Roe, the Goat, and the Sheep, which is most numerous in the latter settlements. With these rank the Fox and the Martens. The Fox indeed, appears, whether from choice or necessity, to have been eaten during the Stone period. This conclusion is derived from the fact that the bones often present the marks of knives, and have been opened for the sake of the marrow. While, however, it is very frequent in the Pileworks of the Stone epoch, it has not yet been found in any settlement belonging to the bronze period. Oddly enough the Dog is, at least in the lake dwellings of the Stone period, rarer than the Fox, though more common than the Horse or the Ass; and of other species but few specimens have been met with, though, in some localities, the Beaver, the Badger, and Hedgehog appear in some numbers.

The Bear and Wolf, as well as the Urus, the Bison, and the Elk seem only to have occasionally been captured; it is probable that the latter species were taken in concealed pits.

From the small lake at Moosseedorf, M. Rütimeyer has identified the following list:—Of the Dog, 3 specimens; Fox, 4 specimens; Beaver, 5 specimens; Roe, 6 specimens; Goat and Sheep, 10 specimens; Cow, 16 specimens; Hog, 20 specimens; Stag, 20 specimens.

It is certainly very striking to find two wild species represented by the greatest number of specimens, and particularly so, since this is no exceptional case; but the whole sum of the wild, exceeds that of the domesticated individuals, a result moreover which is confirmed by the other settlements of this epoch. Not only does this indicate a great antiquity but it also proves that the population must have been sometimes subjected to great privations, not only from the necessary uncertainty of supplies so obtained, but also because we cannot suppose that foxes would have been eaten except under the pressure of hunger.

In his first memoir, Prof. Rütimeyer gives an interesting table which I here subjoin, premising that 1 denotes a single individual; 2, several individuals; 3, the species which are common; 4, those which are very common; and 5, those which are present in great numbers. An x indicates a trace, and I have inserted a + in those cases in which the species have occurred since the table was constructed. I may also repeat that Moosseedorf, Wauwyl, Robenhausen, and Wangen belong to the Stone period while Meilen, and Concise were also inhabited during that of the Bronze, and Auvernier and Steinberg have even produced a few weapons of iron.

		STONE.				BRONZE.			IRON.
		Moosseedorf.	Wauwly.	Robenhausen.	Wangen.	Meilen.	Bienne.	Concise.	Auvernier.
1 The Brown Bear	Ursus Arctos	2	...	...	2	+	...	(x)	
2 The Badger	Meles vulgaris	2	2	1	...	x	...	+	
3 The Martin	Mustela Foina	2	3	...	...	...	...	(x)	
4 The Pine Martin	" Martes	2	3	...	...	1	...	(x)	
5 The Polecat	" Putorius	2	2	+					
6 The Ermine	" Erminea	...	2						
7 The Otter	Lutra vulgaris	1	...	+					
8 The Wolf	Canis Lupus	...	1	+	(x)	x	...	+	
9 The Fox	" Vulpes	3	3	1	1	(x)			
10 The Dog	" familiaris	2	2	2	2	3	3	(2)	x
11 The Wild Cat	Felis Catus	2	2	+					
12 The Hedgehog	Erinaceus europœus	1	+	+					
13 The Beaver	Castor fiber	3	2	...	...	...	...	(x)	
14 The Squirrel	Sciurus europœus	2	2	...	1				
15 The Marsh Boar	Sus Scrofa palustris	5	5	5	5	5	2	(x)	
16 The Wild Boar	" " ferus	2	2	2					
17 The Domestic Hog	" " domesticus	...	?1	...	...	...	3	+	x
18 The Horse	Equus Caballus	?1	2	...	1	2	3		
19 The Elk	Cervus Alces	1	1	2	...	2	1	(x)	
20 The Stag	" Elaphus	5	5	5	5	5	5	(x)	x
21 The Roe	" Capreolus	4	2	2	2	2	...	(x)	
22 The Fallow Deer	" Dama	...	...	...	...	x ?	x		
23 The Ibex	Capra Ibex	...	...	...	...	1			
24 The Goat	" Hircus	2	2	2	...	...	3-4	(x)	x
25 The Sheep	Ovis Aries	2	1	2	...	(x)	3-4	(x)	x
26 The Urus	Bos primigenius	1	+	2	...	...	...	+	
27 The European Bison	" Bison	...	1						
28 The Ox	" Taurus domesticus	5	5	5	5	5	5	(x)	x
29 The Kite	Falco milvus	...	...	1					
30 The Goshawk	" palumbarius	2	1						
31 The Sparrow hawk	" nisus	2							
32 The Ringdove	Columba palumbus	1							
33 The Wild Duck	Anas boschas	3	1						
34 The Garganey	" querquedula ?	2							
35 The Heron	Ardea cinerea	2	...	1					
36 The freshwater Tortoise	Cistudo europæa	1							
37 The edible Frog	Rana esculenta	3	2	+					
38 The Salmon	Salmo salar	1							
39 The Pike	Esox lucius	3	2	...	...	...			
40 The Carp	Cyprinus carpio	2	...	+					
41 The Bleak	" leuciscus	1							

The additional species added since this table was published are:—

42. The Mouse, M. sylvaticus. A single specimen, from Robenhausen. Our common house-mice and rats seem to have been unknown, and even this species is at present represented by but a single specimen.

43. The Hare, Lepus timidus. Of this species only a single bone has yet occurred. It was found at Moosseedorf. It is very remarkable that any nation should have eaten the Fox and spared the Hare, and nothing but a feeling of superstition can account for such an anomaly, which, however, accords well with the entire absence of the Hare from the Kjökkenmöddings of Denmark.

44. The Chamois, Antilope rupicapra. This species is represented by a piece of skull from Robenhausen.

45. A second race of domestic Oxen.

46. The Ass.

The additional birds which have been discovered are:—

Aquila fulva, Meyer. The Golden Eagle. At Robenhausen.
Aquila haliætus. A single bone found at Moosseedorf is rather doubtfully referred to this species by M. Rütimeyer.
Strix alves. From Concise.
Sturnus vulgaris. " Robenhausen.
Cinclus aquatinus "
Tetrao bonasia "
Ciconia alba. Not unfrequent at Moosseedorf and Robenhausen.
Fulica atra. Robenhausen.
Larus. Sp. in "
Cygnus musicus "
Anser segetum "

The additional species of fish are:—

Perca fluviatilis. Robenhausen.
Scardinius erythropthalmus. "
Chondrostoma nasus. "
Lota vulgaris. "

And one or two species belonging to the genus Squalius.

The common Mouse and our two House rats, as well as the domestic Cat and the Barndoor fowl are absent from the Lake habitations of Switzerland as from Kjökkenmöddings of Denmark; at least Prof. Rütimeyer attributes to a later period a single bone of the latter which was found at Morges, a settlement belonging to the Bronze period.

The bones of the Stag and the Wild Boar often indicate animals of an unusual magnitude, while on the other hand the Fox appears to have been somewhat smaller than at present.

The Dogs varied less than at present, in fact they belong to one variety, which was of middle size, and appears to have resembled our present Beagles. (M. Rütimeyer describes it as "resembling the Jagdhund" and the "Wachtelhund."

The Sheep of the Stone period differed from the ordinary form, in its small size, fine legs, and short, goat-like horns: particulars, in which it is nearly resembled by some northern, and mountain varieties at the present day, as for instance by the small sheep of Shetlands, Orkneys, Welsh hills, and parts of the Alps. At Wauwyl, however, M. Rütimeyer found traces of an individual with large horns.

The number of Wild species of Sheep is so great, and our knowledge of them is so deficient, that M. Rütimeyer does not venture to express any opinion concerning the origin of our domestic varieties except that he is inclined to trace them up to several wild races.

It is singular, that though remains of the Horse have yet been found in all the Pileworks, they are so rare that their presence may almost be considered accidental: thus Wangen has only produced a single tooth, Moosseedorf, a metatarsal bone, which has been polished on one side, Robenhausen, a single os naviculare tarsi and Wauwyl, only a few bones, which may all have belonged to a single specimen. On the other hand, when we come to the Bronze period, we find at Steinberg, numerous remains of this species, so that, as far as these slight indications go, the Horse though undoubtedly present in the Stone age, seems to have been rarer than it became at subsequent periods. All the remains of the Horse belonged undoubtedly to the domestic species.

Though he refers some bones to the Wild Boar, and others to the Domestic Hog, yet he considers that the greatest numbers of the remains of this genus belong to a different race, which he calls Sus scrofa palustris. This variety was, in his opinion, less powerful and dangerous than the Wild Boar, the tusks being much smaller in proportion; in fact he describes it as having with the molar teeth of an ordinary full grown Wild Boar, the premolars, canines, and incisives of a young Domestic Hog. He considers that all the bones of this variety from Moosseedorf, belonged to wild individuals, while of those from Nidau-Steinberg, Robenhausen, Wauwyl, and Concise, some bore in his opinion evidences of domestication. It has been supposed by some naturalists that this variety was founded only on female specimens, but in his last work, M. Rütimeyer combats this opinion at some length, and gives copious descriptions and measurements of different parts. He also points out numerous sexual differences in the S. palustris, of the same nature, but not so well marked, as those of the Wild Boar. Relying also on its well defined geographical and historical range, he denies that it can be considered as a cross between the Wild Boar and Domestic Hog, or that the differences which separate it from the former, can be looked upon as mere individual peculiarities. He considers, indeed, that as a wild animal it became extinct at a very early period, though the tame

Swine of India which agree closely with this race may perhaps have been descended from it.

Our Domestic Hog first makes its appearance in the later Pileworks, as for instance at Concise. M. Rütimeyer does not, however, consider that it can have been derived from the Wild Boar (Sus scrofa), nor does he think that it was tamed by the inhabitants of Switzerland, but is rather disposed to look upon it as having been introduced, and the more so, as he finds at Concise traces of an Ox (*B. trochoceros*) which does not occur in the earlier Pileworks. In considering whether a given animal was wild or domesticated, we must be guided by the following considerations; the number of individuals represented; the relative proportions of young and old; the absence or presence of very old individuals, at least of species that served for food; the traces of long, though indirect, selection, in diminishing the size of any natural weapons which might be injurious to man; the direct action of man during the life of the animal; and finally the texture and condition of the bones.

Applying these considerations to the Sus palustris from Moosseedorf, it is evident, firstly, that the argument derivable from the number of young specimens loses much of its force on account of the great fertility of the Sow, and the ease with which the young can be found and destroyed; secondly, in the number of individuals represented, it is equalled by the Stag, which certainly was never domesticated; thirdly, some bones of very old individuals have been found and some of very young, even of unborn pigs; the smallness of the tusks is, according to M. Rütimeyer, a characteristic of the race and not an evidence of domestication; the bones are of a firm and close texture, and the only cases of decay have arisen from an extreme degradation of the teeth, which would certainly be unlikely to occur in a domestic animal. Finally, none of the teeth show traces of any filing or other preparation, except such as may have taken place after the death of the animal, from all of which reasons M. Rütimeyer infers that the inhabitants of Moosseedorf had not yet succeeded in taming either the Sus scrofa palustris or the Sus scrofa ferus.

M. Rütimeyer has paid great attention to the texture and condition of the bones themselves, and in many cases can from these alone distinguish the species, and even determine whether the bone belonged to a wild or a domesticated animal.

In wild animals the bones are of a firmer and closer texture, there is an indiscribable, but to the accustomed eye very characteristic, sculpturing of the external surface, produced by the sharper and more numerous impressions of vessels and the greater roughness of the surfaces for the attachment of muscles. There is also an exaggeration of all projections and ridges, and a diminution of all indifferent surfaces. In the consideration of the remains of Oxen, these distinctions have proved of the greatest importance. By their assistance, and this is in some respects the most interesting part of the work, M. Rütimeyer has convinced himself that besides the two wild species of Bos, namely the Urus (*B. primigenius*) and the Aurochs (*B. bison* or *bison Europeus*), three domestic races of Oxen occur in Pileworks.

The first of these is allied to, and in his opinion descended from, the Urus, and he therefore calls it the Primigenius race. This variety occurs in all the Pileworks of the Stone period. The second or Trochoceros race, he correlates with a fossil species described under this name by F. von Meyer, from the Diluvium of Arezzo and Siena. This variety has hitherto only been found at Concise.

The third, or Longifrons race, is by far the most common of the three. It occurs in all the Pileworks, and at Moosseedorf and Wangen—that is to say, in the settlements which are supposed to be the oldest, almost to the exclusion of the Primigenius race. M. Rütimeyer considers that it is the domesticated form of *B. longifrons* of Owen, but as the word "longifrons" seems to him to be inappropriate and incorrect, he uses the name "brachyceros," which was originally proposed in manuscript by Owen for this species, but which has also been used by Gray for an African species, and ought not therefore to be adopted.

A subsequent portion of the work is devoted to the examination of the existing races of European Oxen. The old Trochoceros race he considers to be extinct, but he sees in the great Oxen of Friesland, Jutland, and Holstein, the descendants of the Bos primigenius. This race does not now occur in Switzerland, but he considers that there are at present in that country two distinct varieties of Domestic Oxen. The one of various shades between light grey and dark brown, but without spots, and prevailing in Schwyz, Uri, Wallis, &c., in fact, in the whole country south of a line drawn from the Lake of Constance to Wallis, agrees in its general osteological characters with the Bos longifrons of Owen. The other or spotted variety, which is generally of smaller size, and prevails in Northern Switzerland, is considered by M. Rütimeyer to be descended from the B. frontosus, a species found fossil in Sweden and described by Nillson.

I will not express any opinion of my own as to these conclusions. The subject is one no less difficult than important, and our space does not permit us to lay before our readers the details given by M. Rütimeyer, to whose work therefore we must refer all those who wish for more information on the subject. All naturalists must feel much indebted to M. Rütimeyer for the labor he spent, and the light he has thrown upon the subject, whether we eventually adopt his conclusions or not.

Human bones occur in the Pileworks but very seldom, and may no doubt be referred to accidents, especially as we find that those of children are most numerous. One mature skull was, however discovered at Meilen, and has been described by Professor His, who considers that it does not differ much from the ordinary Swiss type. And while his work was in the press, M. Rütimeyer received from M. Schwab four more skulls, two of which were obtained at Nidan Steinberg, one at Sutz, and one from Biel.

M. Troyon has a very interesting chapter on the different modes of burial; he points out that the disposition of the corpse after death, had a deep meaning and is perhaps of greater importance than the nature of the tomb, which must in many cases have depended upon that of the materials which came to hand. The Greeks generally burnt their dead; considering fire as the means of purification, while the Persians shrank from such an act, regarding fire, according to Herodotus, as a deity. Other nations, looking upon the earth as the universal mother, returned into her bosom the remains of their dead, fortunately ignorant of the deduction that as we brought nothing into the world so we can take nothing out of it, and regarding it therefore as a sacred duty to bury with the departed his most useful weapons and most beautiful ornaments. This belief seems to have been almost as general as the hope of a resurrection, and even among the Jews we find a trace of it in the words of Ezekiel (ch. xxxii, 27). "And they shall not lie with the mighty that are fallen of the uncircumcised, which are gone down to hell with their weapons of war."

In tombs of the Stone age the corpse appears to have been almost always, if not always, buried in a sitting position, with the knees brought up under the chin, and the hands crossed over the breast.* This attitude occurs also in many Asiatic, African, and American tombs. M. Troyon, quotes the following passage from a work published by André Thévet, in 1575; "Quand donc (speaking of the Brazilian aborigines), leurs parents sont morts, ils les courbent dans un bloc et monceau dans la lit où ils sont décédés, tout ainsi que les enfants sont au ventre de la mére, puis ainsi enveloppés, liés et garrottés de cordes, ils les mettent dans une grande vase de terre." M. Troyon adds, "Chez certains Indiens, les méres, aprés avoir donné á l'homme, avant de l'inhumer l'attitude qu'il avait dans le sein maternel, epanchent

* See for Denmark, Worsaae's Antiquities, Eng. Edit. p. 89. To judge from Mr. Bateman's excellent volume just published, "Ten years diggings in Celtic and Saxon Gravehills," the same position was, to say the least of it, very common in early British Tombs, in which also the corpse was generally deposited on its left side. It would be very interesting if some archæologist would tabulate all the accounts of ancient graves, showing the ornaments and weapons which have been found with different methods of interment.

leur lait sur la tombe. Cet usage des mères, qui assimile l'homme aprés sa mort au petit enfant qu'elles nourrisent de leur lait, s'est conservé, sauf l'attitude, il est vrai, jusqu'au commencement de ce siécle, dans le centre de l'Europe, dans la vallée alpestre des Ormonts;" making this last statement on the authority of M. Terrise, who was himself an eye witness of this extraordinary custom.

Making allowance for the marine animals, such as the seals and oysters, the cockles, whelks, &c., the fauna thus indicated by the remains found in the Swiss lakes, agrees remarkably with that which characterizes the Danish Kjökkenmöddings, and belongs evidently to a far later age than that of the celebrated stone hatchets, which were first made known to us by the genius and perseverance of M. Boucher de Perthes.*

Instead of the Elephant and Rhinoceros we find in the latter or second Stone period, in that namely of the Kjökkenmödding and "Pfahlbauten," the Urus and Bison, the Elk and the Red deer already installed as monarch of the forests. The latter indeed, with the Boar, appears to have been very frequent, and to have formed a most important article of food to the Lake dwellers. The Urus, or great fossil Ox is now altogether extinct. It was mentioned by Cæsar, who describes it as being little smaller than an elephant. (Hi sunt magnitudine paulo infra elephantos, specie et colore et figura tauri.) According to Herberstein, it still existed in Switzerland during the sixteenth century, soon after which, however, it must have become extinct.

The Aurochs, or European Bison seems to have disappeared from Western Europe even earlier than the Urus. There is no historical record of its existence in England or Scandinavia. In Switzerland we cannot trace it later than the tenth century, but it is mentioned in the "Niebelungen Lied," of the twelfth century, as occurring in the Forest of Worms, and in Prussia the last was killed in the year 1775. At one period indeed, it appears to have inhabited almost the whole of Europe, much of Asia, and part even of America, but at present it is confined in Europe, to the imperial forests in Lithuania, where it is preserved by the Emperor of Russia, while, according to Nordmann and von Baer, it still exists in some parts of Western Asia.

We have no notice of the existence of the Elk in Switzerland during the historical period, but it is mentioned by Cæsar as existing in the great Hercynian forest; and even in the twelfth century it was to be met with in Sclavonia and Hungary, according to Albertus Magnus and Gesner. In Saxony, the death of the last is recorded as having occurred in 1746. At present it inhabits Prussia and Lithuania, Finland and Russia, Scandinavia and Siberia, to the shores of the Amoor.

* Whether the Drift race of men were really the aboriginal inhabitants of Europe, still remains to be ascertained. M. Rütimeyer hints, that our geographical distribution indicates a still greater antiquity for the human race.

The Ibex disappeared from most of the Swiss Alps, perhaps not much later than the Elk. It lingered longest in the West. In Glarus the last one perished in 1550, though near Chiavenna it existed until the commencement of the 17th century, and in the Tyrol until the second half of the 18th, while it still maintains itself in the mountains surrounding Mont Iséran.

The extermination of the Bear, like that of the Ibex, seems to have begun in the East, and not yet to be complete, since this animal still occurs in the Jura, in Wallis, and in the South Eastern parts of Switzerland.

The Fox, the Otter, and the different species of Weasels, are still the common carnivora of Switzerland, and the Wild Cat, the Badger, and the Wolf still occur in the Jura and the Alps, the latter in cold winters venturing even into the plains.

The Beaver on the contrary has at last disappeared. It has long been very rare in Switzerland, but a few survived until the beginning of the present century, in Lucerne and Wallis. Red deer were abundant in the Jura and Black Forest in the twelfth and thirteenth centuries, though they do not appear to have been so large as those which lived in earlier times. The last was shot in Basle, at the close of the eighteenth century, while in Western Switzerland and Wallis they lingered somewhat longer. The Roedeer still occurs in some places.

The fauna thus indicated is certainly very much what might have been expected. We find most of the species which charterize the post-tertiary epoch in Europe. Some of the larger ones have since fallen away in the struggle for existence, and others are becoming rarer and rarer every year, while some maintain themselves even now, thanks only to the inclemency and inaccessibility of the mountainous regions which they inhabit. The gradual process of extermination which has continued ever since, had however even then begun.

Taken as a whole, therefore, the animals of the Swiss Pileworks belong evidently to the Fauna, which commenced in post Tertiary times with the Mammoth, the Rhinoceros tichorhinus, the Cave Bear and the fossil hyena. These extinct species appear to have coëxisted in Europe with all of its present indigenous inhabitants; it was, indeed, long supposed that man belonged to a subsequent period, but recent investigations have shown, that he is no exception to the rule.

While, however, we must regard the Fauna of the Stone age as belonging to the same Zoological epoch with that of the later drifts on the one hand, and the present time on the other; we cannot forget that the immense time which had elapsed since the end of the Tertiary period, has produced great changes in the Fauna of Europe. In this Post-tertiary era the Pileworks occupy, so to say, a middle position. Distinguished from the present Fauna of Switzerland in the possession of the Urus, the Bison, the Elk, the Stag, and the Wild Boar, as well as by the more general distribution of the Beaver, the Wolf, the Ibex, the Roe, &c., they differ equally from the drift gravels in the absence of the Mammoth, the Rhinoceros, the Cave Bear, and the Cave Hyena.

M. Rütimeyer, however, thinks that we may carry this division farther, and he considers that some of the Pileworks presenting a more archaic character than others, they may be arranged as follows:—

1stly, Moosseedorf.

2ndly, As being somewhat more recent, Wauwyl, Robenhausen, Wangen, and Meilen.

3dly, The Lake habitations of Western Switzerland.

It is of course unnecessary to point out the interest and importance of such a distinction, which accords so well with that indicated by the study of the weapons and the state of preservation of the piles. Thus, the Urus has only occurred at Moosseedorf and Robenhausen; the Aurochs only at Wauwyl; the Bear only at Moosseedorf and Meilen. A glance at the table given at page 172, will show that several other species have as yet only occurred at Moosseedorf and Robenhausen, a fact however which indicates rather the richness than the antiquity of these localities. Possibly indeed we may consider the presence of these larger species as an indication of their greater abundance in the oldest period; but we must not forget that not only the Bear and the Elk, but also the Aurochs and Urus come down to a much later period. On the other hand, the abundance of wild animals, and the fact that at Moosseedorf and Wauwyl the Fox was more abundant than the Dog, while elsewhere the reverse is the case, certainly speaks in favor of the greater antiquity of these two settlements.

The evidence derived from the distribution of the domestic animals is perhaps more satisfactory. The Sheep is present even at Moosseedorf, though not so numerous as at the Steinberg. On the other hand, the Horse is frequent at the Steinberg, while at Moosseedorf only a single tooth was discovered, and even this had been worn as an amulet or an ornament, and may have been brought from a distance. Finally, the domestic Hog of the present race is absent from all the Pileworks of the Stone period, excepting perhaps the one at Wauwyl, and becomes frequent only at the Steinberg.

If succeeding investigations confirm the conclusions thus indicated, we may perhaps conclude that the domestic animals, which were comparatively rare in the Stone period, became more frequent after the introduction of bronze, a change indicating and perhaps producing an alteration of habits on the part of the inhabitants.

Rare, indeed, as they may have been, Oxen, Horses, Sheep and Goats could not be successfully kept through the winter in the climate of Switzerland, without stores of provision and some sort of shelter. A pastoral people, therefore, must have reached a higher grade than a mere nation of hunters. We know, moreover, in another manner, that at this period agriculture was not entirely unknown. This is proved in the most unexpected manner, by the discovery of carbonized Cereals at various points. Wheat is most common, having been found at Meilen, Moosseedorf, and Wangen. At the latter place, indeed, many bushels were found, the grains being united in large thick lumps. At other times the grains are free, and without chaff, resembling our present wheat in size and form, while more rarely they are still in the ear. Ears of the Hordeum hexastichon L. (the six rowed Barley) are somewhat numerous. This species differs from the H. vulgare L. in the number of rows and in the smaller size of the grains. According to De Candolle, it was the species generally cultivated by the ancient Romans, Greeks, and Egyptians. In the ears from Wangen, each row has generally ten or eleven grains which however are smaller and shorter than those now grown.

Still more unexpected was the discovery of bread, or rather cakes, for leaven does not appear to have been used. They were flat and round, from an inch to 15 lines in thickness, and, to judge from one specimen, had a diameter of four or five inches. In other cases the grains seem to have been roasted, coarsely ground between stones, and then either stored up in large earthenware pots, or eaten after being slightly moistened. A similar mode of preparing grain was used in the Canary Islands at the time they were conquered by Spain, and even now constitutes the principal food of the poorer classes. In what manner the ground was prepared for the cultivation of corn we know not, as no agricultural implements have as yet been found except sickles; it is probable however that bent stakes supplied the place of the plough.

Carbonized Apples and Pears have also been found at Wangen, sometimes whole, sometimes cut in two, or more rarely into four pieces, which had evidently been dried and put aside for winter use. The apples are more frequent than the pears, and have been found not only at Wangen, but also at Robenhausen in Lake Pfeffikon, and at Concise in Lake Neufchatel. Both apples and pears are small and resemble those which still grow wild in the Swiss forests. No traces of the Vine, the Cherry, or the Damson have yet been met with, but stones of the Wild Plum and the Prunus padus have been found. Seeds of the Raspberry and Blackberry and shells of the Hazel nuts and beechnuts occur plentifully in the mud.

From all this, therefore, it is evident that the nourishment of the dwellers in the Pileworks consisted of corn and wild fruits, of fish, and the flesh of wild and domestic animals. Doubtless also milk was an important article of their diet.

The list of plants found in the Pileworks stand as follows:—

Pinus abies.	Corylus avellana.
" picea.	Prunus spinosa.
" sylvestris.	" padus.
Quercus Robur.	Rubus idæus.
Fagus sylvaticus.	" fruticosus.
Populus tremula.	Wheat.
Betula alba.	Hordeum distichum.
Alnus glutinosa.	" hexastichon.

Trapa natans.—This species was supposed to be extinct in Switzerland; but, as M. Troyon informs me by letter, it has recently been discovered in a living condition. It has, however, become very rare.

Flax, Hemp, Juncus, Arundo.

Neither Oats nor Rye have yet been found. Small pieces of twine and bits of matting made of hemp and flax may have been parts of some article of clothing. For the latter purpose also there can be little doubt that the skins of animals were used, and some of the stone implements seem well adapted to assist in their preparation, while the bone pins, and the needles made from the teeth of boars, may have served to fasten them together.

The Pottery of the Stone age presents nearly the same characters in all the settlements. Very rude and coarse, it is generally found in broken pieces, and a few entire vessels have been obtained. The potter's wheel seems to have been unknown, and the baking was very imperfect. The form was frequently cylindrical, but several of the jars were rounded at the base, and without feet. The rings of pottery, which at a later epoch were used as stands, for these earthern *tumblers* are not found in the Lake habitations of the Stone period, but some of the vessels had small projections which were pierced in such a manner that strings might be passed through them, and the vessels might in this manner be suspended. Some of them were also pierced by small holes at different levels. Professor Heer suggests that these may have been used in the preparation of curds, the small holes being intended to permit the escape of the milk.

Several of the vessels are ornamented with simple markings, generally mere impressions of the finger or of the nail. Neither in the Stone, nor in the Bronze period, do we ever find either in the pottery, or on the bronze weapons, any representation, however rude, of an animal; the ornamentation being generally confined to straight or curved lines, forming in many cases a very elegant ornament. One vase, however, which was found at Wangen, is distinguished by more elaborate ornaments, the lines being evidently intended to represent leaves.

The lakes on which Pileworks of the Stone era have as yet been found, are Constance, Zurich, Bienne, Neufchatel, Geneva, Inkwyl, Nussbaumen, Pfeffikon, Moosseedorf, and Wauwyl. Settlements of the Bronze period existed on the Lakes of Geneva, Luissel, Neufchatel, Morat, Bienne, and Sempach, but none have as yet been found on Lake Constance. It has been supposed from this that the age of Stone lasted longer in Eastern than in Western Switzerland, and that flint and serpentine were in use on Lake Constance long after Bronze had replaced them on the Western Lakes. We can hardly suppose that the inhabitants of Inkwyl and Moosseedorf in Berne, who imported flint from France, can have been ignorant of the neighboring civilization on the Lake of Bienne. Perhaps, however, settlements of the Bronze age may yet be found on the Lake of Constance; but as the question now stands, Pileworks of the Metallic period are peculiar to the Western and Central Switzerland. The constructions of the latter period are more solidly built, but do not otherwise appear to have differed materially from those of the Stone age. They are often, however, situated farther from the land and in deeper water, partly no doubt on account of the greater facility of working timber, but partly also, perhaps, because more protection was needed as the means of attack were improved. The principal implements of Bronze are, swords, daggers, axes, spear heads, knives, arrow heads, pins, and ornaments. The number of these weapons which have been discovered is already very great.

From the settlement at Estavayer, in Lake Neufchatel, the following collection of bronze implements has been obtained :—

Pins with large spherical and ornamented heads, 36; Pins with ordinary heads, 92; Knives, 26; Bracelets, 15; Sickles, 5; Axe, 1; Hook, 1; Chisel, 1; Small rings, 27; Buttons, 2; Dagger blade, 1; Arrow head, 1; Pieces of spiral wire, 6; making altogether, 214 objects of bronze.

Again at Morges (Lake of Geneva) forty-two bronze hatchets and thirteen pins have been found. From the Steinberg M. Schwab has obtained five hundred bronze hair-pins, besides other instruments of the same metal. These are of the same type as those found in other parts of Europe, and the swords are characterized, as usual, by the small space allowed for the hand. They were, however, made in Switzerland, as is shown by the discovery at Morges of a mould for celts, and at Estavayer of a bar of tin.

The pottery of this period was more varied and more skillfully made than that of the Stone age, and the potter's wheel was already in use. Rings of earthenware are common, and appear to have been used as supports for the round bottomed vases. As neither copper nor tin occur in Switzerland, the possession of bronze implies the existence of commerce. It is difficult to say from whence the copper was obtained, but Saxony and Cornwall are the only parts of Europe which produce tin. It is however, possible that Asia may have supplied both the one and the other. The presence of amber shows that there must have been a certain amount of communication with Northern Europe.

The Pileworks of Switzerland appear to have become gradually less numerous. During the Stone age they were spread over the whole country. Confined during the Bronze era to the Lakes of Western Switzerland, during that of Iron, we find them only on the Lakes of Bienne and Neufchatel. In these settlements not only has a new substance made its appearance but the forms of the implements are different. We have indeed copies of the bronze axes made in iron, just as we found before that the early bronze celts were copies of the still earlier stone axe, but these are exceptional cases. The swords have larger handles and are more richly ornamented; the knives have straight edges; the sickles are larger; the pottery is more skillfully made and is ornamented with various colors; the personal ornaments are also more varied, and glass for the first time makes its appearance.

Col. Schwab has found at the Steinberg more than twenty crescents, made of earthenware, and with the convex side flattened, to serve as a foot. They are compressed at the sides, sometimes plain, sometimes ornamented, from eight to twelve inches from one horn to the other, and from six to eight inches in height. They are considered by Dr. Keller to be religious emblems, and are taken as evidence of moon-worship. He refers to Pliny, xvi. 95; "Est autum id (viscum) rarum admodum inventu et repertum magna religione petitur et ante omnia sexta luna, quæ principia mensum annorumque his facit, et sæculi post tricesimum annum quia jam virium abunde habeat nec sit sui dimidia; *omnia sanantem appelantes suo vocabulo.*" This passage he translates as follows: "The misletoe is however very rare, but when it is found it is gathered with great religious ceremony, especially on the sixth day of the moon, at which epoch begin their months, years, and divisions of thirty years, because it has then sufficient force, and yet is not in the middle of its course; calling it Heal-all in their language." This name has generally been referred to the misletoe. (See The Celt, Roman and Saxon, p. 48.) But the Swiss archæologists consider that this is a mistake, and that it properly refers to the moon.

A field of battle at Tiefenau, near Berne, is remarkable for the great number of iron weapons and implements which have been found on it. Pieces of chariots, about a hundred swords, pieces of coat of mail, lance heads, rings, fibulæ, ornaments, utensils, pieces of pottery and of glass, accompanied by more than thirty pieces of Gaulish and Massaliot money anterior to our era, enable us to refer this battle field to the Roman era.

After this period we find no more evidences of Lake habitations on a larger scale. Here and there indeed a few fishermen may have lingered on the half destroyed platforms, but the wants and habits of the people had changed, and the age of Pileworks was at an end.

We have, however, traced them through the Stone and Bronze down to the beginning of the Iron period. We have seen evidences of a gradual progress in civilization, and improvement in the arts, an increase in the domestic animals, and proofs at last of the existence of an extended commerce. We found the country inhabited only by rude savages and we leave it the seat of a powerful nation. Changes so important as these are not effected in a day; the progress of the human mind is but slow; and the gradual additions to human knowledge and power like the rings in trees, enable us to form some idea how distant must be the date of their commencement. So varied however are the conditions of the human mind, so much are all nations affected by the influence of others, that when we attempt to express our impressions, so to say, in terms of years, we are baffled by the complexity of the problem, and can but confess our ignorance. Occasionally indeed we obtain a faint glimmer of light but the result is only to show us obscurely a long vista, without enabling us to define any well marked points of time. Thus in Denmark we found three periods of arborescent vegetation, corresponding to the three epochs of human development, and we know that the extermination of one species of forest tree and its replacement by another is not the work of a day. The Swiss archæologists, however, have attempted to make an estimate somewhat more definite than this.

The torrent of the Tinière* at the point where it falls into the Lake of Geneva, near Villeneuve, has gradually built up a cone of gravel and alluvium. In the formation of the railway this cone has been bisected for a length of one thousand feet, and to a depth in the central part, of about thirty-two feet six inches above the level of the rails. The section of the cone thus obtained shows a very regular structure, which proves that its formation was gradual. It is composed of the same materials (sand, gravel, and larger blocks) as are even now brought down by the stream. The detritus does indeed differ slightly from year to year, but in the long run the differences compensate for one another, so that when considering long periods and the structure of the whole mass, the influences of these temporary variations, which arise from meteorological causes, altogether disappear, and

* See Morlot, Leçon d'Ouverture, &c.

need not therefore be taken into account. Documents preserved in the archives of Villeneuve show that in the year 1710 the stream was dammed up and its course a little altered, which makes the present cone slightly irregular. That the change was not of any great antiquity is also shown by the fact that on the side where the cone was protected by the dykes, the vegetable soil, where it has been affected by cultivation, does not exceed two to three inches in thickness. On this side, thus protected by the dykes, the railway cutting has exposed three layers of vegetable soil, each of which must, at one time, have formed the surface of the cone. They are regularly intercalated among the gravel, and exactly parallel to one another, as well as to the present surface of the cone, which itself follows a very regular curve. The first of these ancient surfaces was followed on the south side of the cone, over a surface of 15,000 square feet; it had a thickness of four to six inches, and occurred at a depth of about four feet (1·14 metre measured to the base of the layer) below the present surface of the cone. This layer belonged to the Roman period, and contained Roman tiles, and also a coin.

The second layer was followed over a surface of 25,000 square feet; it was six inches in thickness and lay at a depth of 10 feet (2·97 metres, also measured to the bottom of the layer). In it have been found several fragments of unvarnished pottery, and a pair of tweezers in bronze, which to judge from the style belonged to the Bronze epoch. The third layer has been followed for 3500 square feet; it was six or seven inches in thickness, and lay at a depth of 19 feet (5·69 meters) below the present surface; in it were found some fragments of very rude pottery, some pieces of charcoal, some broken bones, and a human skeleton with a small, round, and very thick skull. Fragments of charcoal were even found a foot deeper, and it is also worthy of notice that no trace of tiles was found below the upper layer of earth.

Towards the centre of the cone, the three layers disappear, since, at this part, the torrent has most force, and has deposited the coarsest materials, even some blocks as much as three feet in diameter. The farther we go from this central region the smaller are the materials deposited, and the more easily might a layer of earth, formed since the last great inundations, be covered over by fresh deposits. Thus, at a depth of ten feet, in the gravel on the south of the cone, at a part where the layer of earth belonging to the bronze age had already disappeared, two unrolled bronze implements were discovered. They had probably been retained by their weight, when the earth, which once covered them, was washed away by the torrent. After disappearing towards the centre of the cone, the three layers reappear on the north side, at slightly greater depth, but with the same regularity and the same relative position. The layer of the Stone age was but slightly interrupted, while that of the Bronze era was easily distinguishable by its peculiar character and color.

Here, therefore, we have phenomena so regular, and so well marked that we may apply to them a calculation, with some little confidence of at least approximate accuracy. Making then some allowances, for instance, admitting three hundred years instead of one hundred and fifty, for the period since the embankment, and taking the Roman period as representing an antiquity of from sixteen to eighteen centuries, we should have for the age of Bronze an antiquity of from 2900 to 4200 years, for that of the Stone period from 4700 to 7000 years, and for the whole cone an age of from 7400 to 11,000 years. M. Morlot thinks that we should be most nearly correct in deducting two hundred years only for the action of the dykes, and in attributing to the Roman layer an antiquity of sixteen centuries, that is to say, in referring it to the middle of the third century. This would give an age of 3800 years for the Bronze age and 6400 years for that of Stone, but on the whole he is inclined to suppose for the former an antiquity of from 3000 to 4000 years, and for the latter of from 5000 to 7000 years.

In the settlement at the foot of Mt. Chamblon we have, according to M. Troyon, a second instance in which we obtain at least some approximation to a date. The interest which attaches to this case arises from the fact that Pileworks have been found in the peat at a considerable distance from the lake, whereas it is evident that at the time of their construction the spot in which they occur must have been under water, as this mode of building would have been quite out of place on dry land. This however indicates a very considerable antiquity, since the site of the ancient city Eburodunum must have been, at that time, entirely covered by the lake, and yet the name, which is of Celtic origin, denotes that there was a town here even before the Roman period. In order, however, to form an idea of the time at which the dwellings at Chamblon were left dry by the retirement of the lake, we must have in the valley a point of determined age, to serve as a term of comparison, and such a point we find in the ancient city of Eburodunum (Yverdon), which was built on a *dune* extending from Jorat to the Thiéle. Between this *dune* and the lake, on the site at present occupied by the city of Yverdon no traces of Roman antiquities have ever been discovered, from which it is concluded that it was at that period under water. If then we admit that at the close of the fourth century the lake washed the walls of the Castrum Eburodense, we shall have fifteen centuries as the period required to effect this change. The zone thus uncovered in fifteen hundred years is 2500 feet in breadth, and as the piles at Chamblon are at least 5500 feet from the water, it may be inferred that three thousand three hundred years must have elapsed since they were left dry. This Lake dwelling belonged to the Bronze period, and the date thus obtained, agrees pretty well with that obtained from the examination of the Cone de la Tinière. M. Troyon adds that "rien ne fait soupçonner, pendant l'époque humaine et antérieurement à notre ére, des conditions d'accroisement differentes de celles qui ont eu lieu posterieurement aux Romains; le résultat obténu est même un minimum, vu que la vallée va se rétrécissant du côté du lac et que nous avons admis la présence de celui-ci au pied même d'Eburodunum dans le IV[e] siècle de l'ère chretienne, tandis qu'il est probable que la retraite des eaux n'a pas été insensible depuis le moment où les Romains se sont fixès sur ce point."

However this may be, and while freely admitting in how many respects this calculation is open to objection, we may still observe that the result agrees in some measure with that given by the Cone de la Tinière. The ancient history of Greece and Rome, as far as it goes, tends to confirm these dates, since we know that at the time of Homer and Hesiod, arms were in part at least, made of iron, and as we know that at a very early period, there was a certain amount of commerce between Helvetia and the shores of the Mediterranean, we can hardly suppose that a metal so immensely important as iron, can have remained unknown in the former country, long after it was generally used throughout the latter.

Still, though we must not conceal from ourselves the imperfection of archæological record, we need not despair of eventually obtaining some more definite chronology. Our knowledge of primitive antiquity has made an enormous stride in the last ten years, and the future is full of hope. I am glad to hear from M. Troyon that the Swiss archæologists are continuing their labors. They may feel assured that we in England await with interest the results of their investigations.

ART. XVII.—*Upon the structure of the Brain in Man and Monkeys, and its bearing upon classification, with special reference to the views of Owen, Huxley and Gratiolet;* by R. WAGNER.*

OWEN has proposed a subdivision of the mammals [see this Journal for 1848, pp. 7 and 177] founded upon the structure of the brain and more particularly upon that of the cerebrum and the presence or absence of gyrations upon it. The two lower of the four sub-classes he makes, the Lyencephala and Lissencephala, including the Monotremata, Marsupialia, Rodentia, Insectivora, Cheiroptera and Edentata, have the hemispheres of the

* From Archiv f. Naturgeschichte, 1861.

brain smooth or nearly so and the corpus callosum wanting or rudimentary, in which characters they approach the Ovipara and especially the birds. Some orders are thus removed from their former higher position. The Quadrumana, Carnivora, Solidungula, Ruminantia, Pachydermata, and Cetacea, form the second of his upper sub-classes or the Gyrencephala. In them the brain, excepting in the small clawed monkeys [Lemurs and Ouistits?], is strongly grooved and has a well developed corpus callosum, and by their higher faculties they are connected with man as his servants and companions. In man the cerebrum at a still higher stage of development spreads itself to a greater degree over the ethmoid lobe, [Riechlappen] and the cerebellum and even develops into the so-called third lobe of the cerebrum. This third or posterior lobe together with the posterior horn of the lateral ventricle and the pes hippocampi minor he regards as peculiar to man, who therefore constitutes not as hitherto merely an order, but a sub-class, the Archencephala. Owen remarks further that he cannot regard man and monkeys so distinct as does the author of Records of Creation, but as Linné and Cuvier have done, must consider them fit subjects for zoologic comparison and classification, especially as he is unable to distinguish in the mental phenomena of a chimpanzee and a bushman or half formed aztec other than differences of degree.

Owen's views appear to me somewhat altered in his communication at the last meeting of the British Association at Oxford, as reported in the Athenæum. He there said that the brain of the gorilla differed more from that of man than did that of the lowest and most problematic quadrumane, since there were parts in the human brain wholly wanting in the gorilla.

At the same meeting Huxley, in opposition to the views of Owen, denied that there is any such vast difference of structure between the brain of man and monkeys and referred to the dissections and figures of Tiedemann in support of his statement. He thought the difference between man and the highest apes in regard to the brain structure not to be so great as that between the highest and lowest apes. More recently in the "Natural History Review" for January, 1861, he has developed the same argument quite at length. Huxley maintains against Owen: 1. That the posterior lobe is not peculiar to man and is found in all quadrumanes; 2. That the posterior horn of the lateral ventricles exists also in the higher quadrumanes; and 3. that such is also the case with the pes hippocampi minor. Further that the two latter on the general testimony of human anatomists are variable and inconstant in man, so as really to be of little value as distinctive characteristics; and hence Huxley concludes that it may fairly be questioned whether the separation of man as a subclass from the other mammals is founded in fact. He admits, however, that there still remain the following distinctions between the brains of men and monkeys: 1. In anthropoid apes the brain is smaller in proportion to the nerves having origin in it; 2. The cerebrum is smaller in proportion to the cerebellum, and 3. the gyrations of the hemispheres are shallower and more symmetric; while 4. in man the proportions of the various lobes to each other differ from those of corresponding lobes in the quadrumanes.

The first of these has been known since Sœmmering, the three others were established by the works of S. v. d. Kolk, Vrolik and Gratiolet. Sœmmering and Tiedemann are at variance as to the relative size of the nerves and the brain in the higher and lower races of men, but the latter considers the cerebellum to bear a larger proportion to the whole brain in the lower races. From the published dissection of the Hottentot Venus and the works of Gratiolet and Tiedemann, Huxley thinks the anterior development of the brain to be less in the lower races of men than is common with Europeans, and therefore that the differences between the European and bushman brains are of the same kind and degree as those between the bushman and orang brains. He wished that the surgeons at the Cape of Good Hope, India and Australia, would threw more light upon this interesting question by comparative dissections of the lowest races there, and concludes that as the brains of *Lemur mungos*, *Stenops tardigradus* and *Perodicticus*, differ so greatly from those of other monkeys, it is clear that the Quadrumana differ more among themselves in brain structure than some of them do from man, and that the separation of Homo and Pithecus in distinct subclasses while Pithecus and Cynocephalus are in one order is incompatible at least with the affinities of their brain structure.

M. Gratiolet's classic work, "Mémoire sur les plis cérébraux de l'homme et des primates" has so completely described the brains of the Quadrumana that their brain structure, at least as regards the external gyrations and lobes, is known better than that of any other group of animals. This work fairly surpasses all that has ever been done in this direction hitherto. M. Gratiolet has more recently (Comptes Rendus, 1860) investigated the brain structure of the gorilla, and has also given (Mémoires de la Société d'Anthropologie de Paris, 1860, tome 1, p. 64,) a comparative view of the brain development in man and monkeys. He says: "While this colossal ape, the gorilla, approaches man more nearly than any other ape in the strongly developed thumb and in the bones of the wrist, it rather approaches the Cynocephali in its brain and skull." More recently he has announced that by a study of the brain of the human microcephalus [idiot by arrest of development] and the development of the quadrumane brain, he is convinced that palpable anatomical differences are evident. "I have found by a careful comparison of adult brains in men and monkeys, that they are arranged on the same plan as to the gyrations, and when the view is thus limited to the adult structure there is no marked ground for separating them. But in studying the development I find that in apes the gyrations of the posterior lobes appear before those of the anterior lobes which is just the reverse of their succession in man. In one the developement is from α to ω, in the other from ω to α, and hence it follows that no arrest of the development of a human brain can make it resemble that of an ape. This conclusion is borne out by a study of the brains of human microcephals. At first view one of them might be taken for the brain of a new species of ape, but the least observation corrects the error. In apes the fissura longitudinalis* is always long and deep; in the human microcephal, this fissure is always incomplete and often wanting, the sphenoid lobe being wholly smooth. Further, in the microcephal, the second connecting gyration (le deuxiéme pli de passage) between the occipital and parietal lobes which is a special characteristic of man is visible on the surface. In the orang brain on the contrary it is constantly concealed under the operculum of the posterior or occipital lobe. In its atrophied condition the microcephal brain, though it may be smaller and have fewer gyrations than the brain of an orang or chimpanzee, still shows its human character. The microcephal or idiot however low is no animal, he is only a reduced human being.

"I have endeavored to ascertain whether microcephalia precedes birth or not. In some microcephals the form of the brain and of the fissure of Sylvius showed the disease to be quite as early as the fifth month. Its cause is to be sought perhaps in some general influence, some primitive genetic weakness (Asthéniogénie) by which the abnormal form is produced. In the normal child at birth the gyrations of the brain are complete. This is also the case with the young of all animals that are born with open eyes, those that do not open their eyes till some time after birth do not complete the gyrations till then. If idiocy by arrest of growth took place after birth the completed brain would continue to show that completed structure, being infantine only in size. Such is not the case however. The abnormal condition occurs long before the curve of the brain is shortened and its growth ends also early, before the normal period of close. The enormous proportional development of the cerebellum in these little beings is interesting, for it is a proportion that puberty never attains. This fact is opposed to the theories of Gall in regard to the functions of the cerebellum, but on the other hand favors the views of Flourens. The microcephal usually moves

[* A fissure on the inner surface of the hemispheres just above the corpus callosum.]

with certainty, speed, and by an harmonious control of his muscular system. The strong relative development of the myelon or spinal cord is in conformity with these facts.

"The atrophy then in these creatures is confined almost entirely to the hemispheres of the brain. The organs of sense are large and well developed and the nerves which supply them have usually a proportional development far surpassing a normal one.

"I may remark here that as microcephals have the material and zoölogic marks of man, so have they also man's distinctive faculties. Most have a language, not rich it is true, but still articulate and distinct. Their brains in appearance below those of an orang or a gorilla, are still the habitation of a speaking soul. This innate, and as it were, inextinguishable quality, is man's highest and most distinctive feature; and however lowered by disease or imbecility, man is still human, not an ape.

"The microcephals wanting a part of their brain gyrations, are all small. I may mention in this connection the proportion that has been observed for some time between the complexity of the brain gyrations and the general size of the animal. It is true that all large animals have gyrations, whilst the greater proportion of small animals are destitute of them. Still I think the relation has not been justly conceived of. The presence of gyrations indicates not so much the great size of the individual [or its species], but rather that the whole zoologic group to which the individual belongs* consists essentially of large forms. Hence it is that the smallest species of those natural groups which include or consist mainly of gigantic forms have gyrations of some sort, as the weasel among the carnivores and *Antilope hemprichiana* (Ehr.) and *A. spinigera* (Temm.) among the ruminants.

"Among human races the bushman brain has very simple gyrations and the anterior lobes have a simplicity never seen normally in white races. But bushmen are neither microcephals nor idiots. The very fact that this incomplete brain suffices for the functions of life shows that it is a normal and in one sense a specific condition, and that as related to man the bushmen are not degraded beings (êtres degradés). The race is fruitful. Its persistence amidst constantly adverse influences shows this. Every observation confirms the view that degraded forms of a species tend toward extinction.

Gratiolet concludes that "man is separated from the animals as completely by his physical organism as he is by his mental phenomena."

[Some very general remarks of Dr. Wagner are here omitted.]

[* It may be interesting to observe here that the hemispheres of the Capybara, the largest living rodent, have gyrations, contrary to the general rule among rodents.]

As regards the application of the brain structure to zoölogic classification, which I believe Leuret first,* and more recently Agassiz in regard to the turtles, suggested, the attempt of Owen among mammals shows its failure to be that of any other single anatomical character so used. As with the classification of fishes proposed by Müller and that by Agassiz, every application of a single organic character fails when carried out, leaving gaps that destroy the uniformity of the whole. It is the sum of the mutual relation of the individual parts of the structure that measures affinities, rather than individual marks of structure through the highest. The very objections, which Müller urges against Agassiz's classification by scales, may be applied with equal force to Müller's classification, based on the valves of the bulbus arteriosus.

There is much that suggests thought in Owen's application of the brain structure to classification. The importance of the organ leads one to expect beforehand that it should, better than any other individual character, mark the scale of the being. But the distinctions between morphologic and physiologic equivalents (analogies, homolgies, &c.), are still so indefinite and disputable as to demand the greatest caution; and though I accept, I must still regard them as obscure conceptions rather than as scientific facts.

In regard to the gyrations of the brain it seems surprising that so large, highly organized, and physically elevated an animal as the ostrich has smooth hemispheres like the lower mammals. Nor in man do the gyrations seem to hold a constant relation to the mind. The brain of the mineralogist, Hausmann, who had a body of more than ordinary size, appears to me similar to that of the Hottentot Venus or of a seventh month embryo. We do not know what relation the terminal gray substance of the surface may hold to the white fibres or to the nerve origins of the brain and spinal cord, nor their special psychical significance.

On the other hand the typical arrangement of the gyrations and the formation of the lobes of the cerebrum are certainly in intimate relation to the systematic division of the groups, orders and families. The ruminants, carnivores and quadrumanes give evidence of this, and the genera even may be known by their arrangement. But it is only the individuals of one order or family, and especially those of a marked natural group, that may be justly compared as to the relative development and arrangement, and in the number and details, of their gyrations.

[* Leuret's work bears date 1839; but Jourdan had before that, (*Comptes Rendus*, 1837.) read before the Academy a paper on a classification, adopted by him for the Museum of Lyons, based on the structure of the nervous system, and in the fall of the same year prince C. L. Bonaparte read before the Linnean Society of London a paper classifying the mammals according to the lobes of the brain, which principle he confessed he owed to Jourdan.—*Trans. Lin. Soc.*, xviii.]

So then we say that in a broad point of view man forms one group with the monkeys, in a narrower sense he forms a group by himself. And this from the structural arrangement of his brain and the configuration of its gyrations.

I do not understand how so much emphasis has been given to unessential parts that vary even among men; as the posterior horn of the lateral ventricle, the pes hippocampi minor and even the emminentiæ candicantes [corpora mammilaria] as distinctive of man. [Reference is here made to Serres' view, that the so-called corpora mammillaria of animals really represent the tuber cinereum.]

The plan and arrangement of the lobes* is one for man and the monkeys, and the fissures and the position of the various parts make a striking resemblance between even the lowest ape's brain and that of man.

Even if the difference of development pointed out by Gratiolet be given its utmost force, there is still a striking resemblance between the early stages of the human brain and the various grades of quadrumane brain structure. It is true the frontal lobes are peculiar by the early appearance of their gyrations, and yet between the smooth lobes of a fifth month human embryo and the smoothest hemispheres of the clawed quadrumanes, there is a marked resemblance. And so there is a similarity, in the few and symmetric gyrations of both hemispheres, and in the smaller and indistinct gyrations of the frontal lobes of the sixth or seventh month human fœtus, to many higher qudrumane brains; while the highest anthropoid apes are brought still nearer by the symmetry and number and depth of their gyrations, and by the presence even of the small gyrations in the insula Reilii. But they are always remarkably behind man in the overwhelming proportional development of his cerebrum to the whole brain and especially to the cerebellum, whilst essential differences occur as to the order, size and limits of the occipital lobes, for in the

[* The division of the brain into lobes as proposed by Gratiolet is as follows: The *central lobe* is the insula Reilii. The fissure of Sylvius running outward, upward and backward from this separates the *temporo-sphenoidal* or *temporal lobe* below, from the *frontal* and *parietal lobes* above, and finally terminates in the *external vertical fissure* of Gratiolet. This latter fissure passing outward and downward from the median line or inner surface of the hemispheres separates the *parietal lobe* above, and the *temporal lobe* below, from the *occipital lobe*. The ascending convolution in front of the fissure of Rolando separates the *parietal lobe*, in which it is included, from the *frontal lobe*. The continuation of the external vertical fissure on the mesial surface of the hemispheres is known as the *internal vertical fissure*. The *operculum* is the superior sharply defined edge of the occipital lobe, which partly overlies the *parietal* lobes in orangs. The *external vertical fissure* of Gratiolet appears to be rarely if ever filled up by connecting gyrations (plis de passage) in quadrumane brains, while in the mature human brain it is generally so filled. Owing to this it will be difficult perhaps to identify this fissure without a comparison of the brain of a seventh or eighth month fœtus. See further a summary of Gratiolet's work, *Ann. des Sci.*, 3me Série, t. xiv, p. 184, 1850.]

orang these lie lid-like [operculum] upon the gyrations that Gratiolet has called connection folds [plis de passage]. I may note here what Gratiolet has not mentioned, that the gyri breves of the insula Reilii are present in the orangs, and that, as I have elsewhere shown—"Vorstudien zu einer wissenschaftlichen Morphologie des Menschlichen Gehirns,"—the gyrations of the posterior lobes cannot be absolutely compared with those of man.

I however agree with Gratiolet, that there is no absolute identification of the human brain, not even of the microcephal, with the quadrumane brain. In a cast of a microcephalous brain, I find the occipital and parietal lobes quite small, the first indeed is almost wanting, so as to leave the cerebellum exposed. The cerebellum is however strongly developed. In the orang the occipital lobes are large and as is the case I believe in all brachycephalous and dolichocephalous races of men it completely overlaps the cerebellum. There is no closer approximation between the brains of men and monkeys than there is between their skulls. In the human microcephalus and the anthropoid apes, the brain pan (Schadelkapsel) is of a like size or even larger in the latter, the jaws project similarly, the arched line of the origin of the temporal muscle is higher and forms, even in the microcephal, a sort of crest or ridge, the proportions of the supra and inter maxilaries, the form of the nasals the canines (Eckzähne) and the chin are alike; but the whole shape, arrangement and connection of the facial bones of the microcephalus are yet so clearly human, that typical comparison separates them from the most anthropoid apes, and that on fundamental grounds. From all we know of the normal and abnormal human and ape structure, the two are separated as widely as birds and mammals, as monotremes (Schnabelthier) and ostriches or ducks since these show a superficial relation in bill, cloaca, and clavis. All I know of zoology and physiology is opposed to any such transmutation as Darwin suggests. Men and apes without any consideration of their mental phenomena are primitively and absolutely different in material structure.

[In a later number of the same Journal, Dr. Wagner makes some further observations upon the microcephalous brain, and sums up in the following interesting conclusions.]

1. In adult and strong microcephals the brain is less in weight and size than in a new-born child. This reduction of the brain mass is not however uniform in all its parts.

2. For while the cerebrum is less than that of a new-born child, the cerebellum is larger. The proportion of the cerebellum, corpora quadrigemina, medulla and pons varolii, to the cerebrum in well formed adults is as 1 to 7 or 8 in man, as 1 to 5 in orangs, as 1 to 3 or 4 in adult microcephals.

3. Further, while the four lobes of the cerebrum are stunted, the temporo-sphenoid lobe is least affected, the frontal next, and

the parietal and occipital lobes are most so. The central lobe—insula Reilü—with its gyrations appears to be wanting or very rudimentary in the lower microcephals as is also the operculum (Klappdeckel), while all of these are present in the orang.

4. Though the gyri are smaller, stunted or wanting, and the gray layer is thinner in the brains of microcephals, yet so far as the gyri are present they show the same relation and order as in the normal human brain. This normal arrangement, so far as I may judge from casts of the hollows of skulls and from a few dissections, is the same in type for all races of men.

5. The lateral ventricle appears relatively larger in the microcephal, and this shows that there is an early arrest of development, usually occurring in the third or fourth month, at which time the parietal and occipital lobes begin to grow, the central lobe is still rudimentary and the frontal and temporal lobes, especially the latter, have quite a development. The embryonal condition of some bones of the skull confirms this view. But this arrest is not so much arrest of growth as of development, the gyri and lobes increasing slowly in size and the atrophy or limitation being mostly shown in those parts that are undeveloped at the time of the arrest.

6. The resemblance to the brain of apes and particularly to that of the chimpanzee is only apparent, and consists mainly in the lesser size of the gyri and their consequent symmetry, while fundamental points, as the greater development of the occipital lobe, the posterior occipital fissure, &c., show distinctive ground plans for the two orders, Bimana and Quadrumana.

7. The condition of the bone tissue, the occasional asymmetry of the skull, the welding of the sutures, make it probable that in such cases a primitive disease of the bone tissue or rather of the whole nutritive system plays a part, as H. Müller has shown in fœtal rachitis.—(*Würburg Medic. Zeits.*, 1860.)

8. The anatomical condition of the microcephalous brain—see above—confirms the view that the cerebellum is not related to the intelligence but to the motor faculties. For whilst the intellect is extraordinarily wanting, the latter are hardly if at all deficient. It is true microcephals usually learn to walk late and have an uncertain or stumbling gait, but they are often quick and nimble in climbing. The complete integrity of the senses, especially of sight and hearing, favors the view that the transformation of sensations into perceptions, (Vorstellungen) takes place in the interior elements of the brain, in the basal part of the cerebrum, rather than in any part of the superficial layer which may exist in the frontal and temporal lobes.

The relation between the cerebrum and the intelligence is so express that we may say it is a certain amount of development of the former that is followed by the distinctive human faculties.* The microcephals appear in this point of view to be below all mammals and birds. The more idiotic can only repeat like parrots some words they have often heard, and are not educable. When there is a certain amount of brain substance with a formation of the normal gyrations then it will depend upon education whether the higher intelligence manifests itself or not. It is however in a limited sense that we say the greater size of the cerebrum and richness of its gyrations run parallel with intelligence, though on the whole the brains of known great men stand generally at the top of the scale.

[It will be seen that Wagner, though always remarking that man is distinct from the Quadrumana, has not met the objections of Huxley; nor are we aware that Gratiolet has given any data for clearing up the apparent inconsistency in separating man as a sub-class, upon the structure of his brain, from the quadrumanes, while as great or greater differences exist among the genera of that order. But while it would be interesting to know how far the brains of the prosimiæ are essentially identical with those of the true simiæ, the formation of the sub-class, Archencephala, as coördinate to that of the Gyrencephala, does not seem to depend on such an identity. For man may be so separated on other grounds. On the distinction of mind, as is well known, he has already been removed by some zoologists to a separate sub-kingdom or even declared not to be the subject of zoologic classification. There being such strongly marked distinctions then, and these—the faculties of mind—being so closely related to the cerebrum as their organ, a uniform variation existing in this remarkably human organ would be sufficient, were there no other external distinctions, to characterize man from the most anthropoid apes or really from the whole of the Gyrencephala; though the same amount of variation could not be used for separating the genera of an order in which this organ and its function are not a characteristic feature.† Not that this organ is peculiar to man, but that it is emphasized in him, and that the high exercise of its function is one of his most marked traits. As such, a variation and especially a variation in the

* The following table of measurements of the brain given in another place is illustrative of this:

	Length.	Breadth.	Height.
Gauss the mineralogist,	185	141	125
Dutch,	168	131	125
Tunguse,	165	143	116
Russian,	167	131	120
Negro,	175	128	115
Microcephal aged 31 years,	102	66	71
" " 26 "	101	65	73
Old Orang Outang	101	108	87

The measurements are in millimetres.

[† Thus the interparietal has lost its irregular character as triquetral bones in the Rodents and become a very fixed trait in their skulls. The variation of this bone serving to mark genera in that order, while in man it varies from individual to individual.]

method of development, as shown by Gratiolet, is really of great force: granting however that if the distinctive faculties of mind did not follow this variation as a normal result, the mere variation in itself could not have such weight. Hence we think Huxley's objections are rather against the separation of man as *Archencephala*, than against the separation itself; and as such more specious than real, for it would be of equal force in logic to object against it that the ruminant or cetacean brain differs more from the quadrumane than that of man does from the chimpanzee's.

But the brain, however important in function, is really an obscure internal organ, and since there is so complete a relation between the external form and the mind even, some external feature would better have been chosen as characteristic of the sub-class. It has long been observed that man is more justly characterized by his great toe than by his thumb, by his foot than by his hand, since the former imply the erect attitude. When we see how the gradual elevation of the brain end of the body runs parallel with an elevation of zoologic grade as shown by C. G. Carus and others, we see one mark of high rank in this striking external trait. When we further consider that the locomotive function is performed by the spine and mesial fins in lower vertebrate forms is gradually shared by members not on the mesial line, and becomes more and more exclusively the work of these members, while the spine is successively shortened, until in man we have only the posterior pair of members applied to locomotion, we find another character of elevation in this posture. Carus has remarked that in using only one pair of members for locomotion, and leaving the other pair free to sensation and esthetic uses, man stands alone among animals. More recently Prof. Dana has mentioned the same idea to the writer, and has further emphasized it by observing that this application of members to the uses of the head in man is analogous to that cephalization which he has long ago shown to be a principal of elevation in the Crustacea.

To sum up then in regard to the order Bimana: the thumb and hands of the gorilla are far more powerful than those of man. But they are really organs of locomotion in these arboreal animals. Man alone has a foot with toe and heel that plants itself firmly, he alone stands erect among beasts, he alone having four well developed members uses only two for progression. With him the hand is an organ of sensation and belongs to the head, the central organ of the senses. This and all other marked features point to the human head as dominant over the whole body and to the subjection of all other functions to its functions of sensation, perception and thought.

These striking features are peculiar to man among the vertebrates, and thus on merely zoologic grounds he is clearly separated from other mammals, and justly forms a sub-class by himself, even without regard to his mental phenomena—if it were posssible to conceive of their absence in such a structure.

The significance of the other sub-classes also is more evident, when we consider their size and organic development rather than their mere brain structure. Hence Prof. Dana has suggested to the writer the terms Macrencephala and Micrencephala for Gyrencephala and Lissencephala, the one being principally of large forms and the other—with the exception of the Edentata which however show a sluggish overgrowth—of corresponding small forms.

The Lyencephala would seem also to be better characterized by the short gestation and the premature birth of their young, than by the greater or less development of their corpus callosum; though such indications of an unfinished structure are interesting confirmations of their premature condition. It might also be objected that the term is too much like Lissencephala to be a really good one.

It is interesting to observe, in the phenomena presented by microcephals, that the typic development may be arrested, while a vegetative growth or mere increase in size may still continue in the part so arrested; indicating two kinds of forces, typic or formative, and nutritive. The former of these is essentially hereditary, governs the embryonic life and form, and gives rise more especially to the varieties of a species; the latter productive of growth and health is rather influenced by the conditions of life, food, &c.—W. C. M.]

New Haven, Aug., 1862.

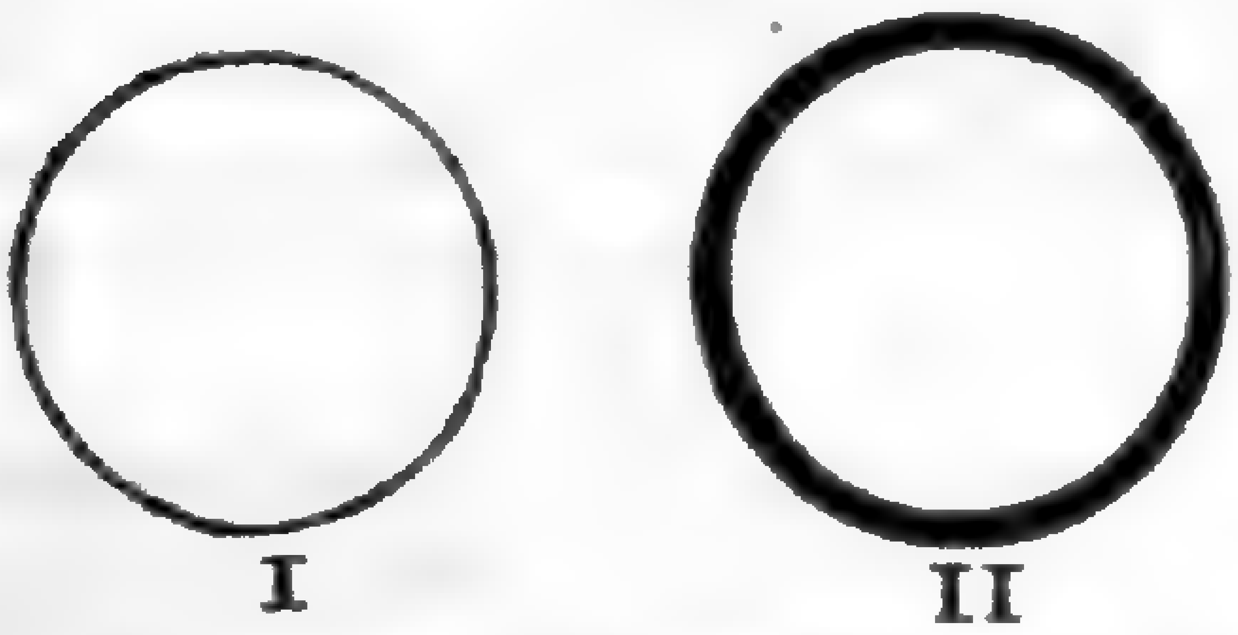
Art. XVIII.—*On some Stereoscopic Experiments;* by Professor O. N. Rood, of Troy, N. Y.

1. *On the Binocular Combination of Drawings in fine and thick lines.*

Several years ago, Dove studied the curious effects produced by the stereoscopic union of linear drawings, in which the right and left hand projections were executed in different colors. Related to this, in a certain degree, is the case of the binocular union of drawings in the same color, but with the corresponding parts consisting of fine and thick lines.

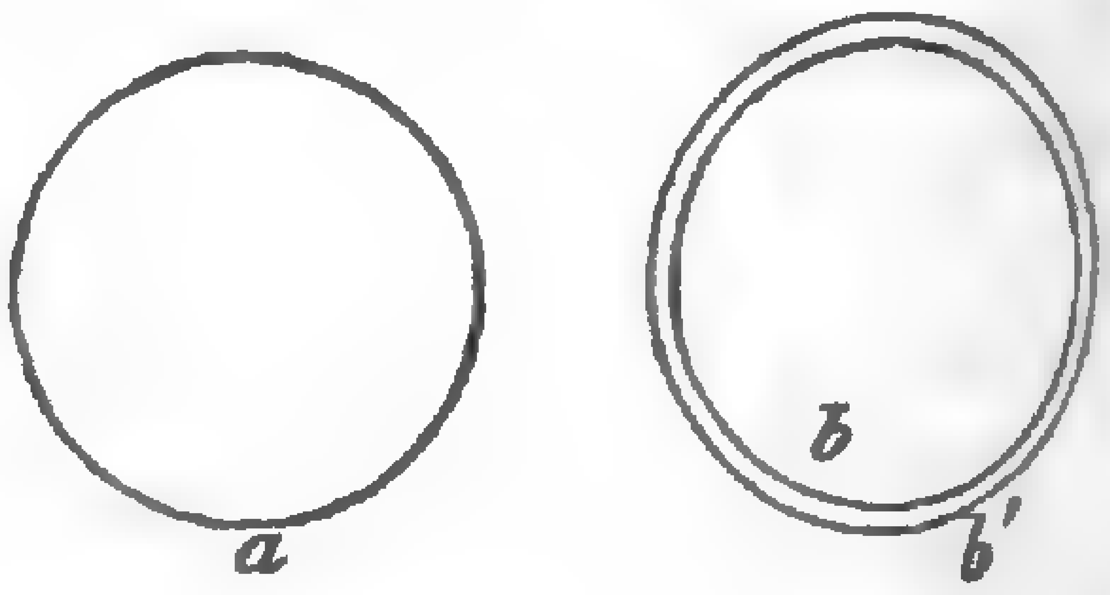
I made in this manner, on a white ground, two projections of a convex pyramid; the lines of the right hand picture having three times the diameter of the corresponding lines of the left. Both sets of lines were black. In the stereoscope the relief was found to be but little impaired, although no proper fusion of the fine and thick lines had taken place: it was found, that the fine lines of the one projection combined with the edges of the thick lines in the other, where the former remained plainly distinguishable. With another drawing, in which the thick lines were six times as broad as the fine, the latter still combined with the edges of the former, but the relief was obtained only with effort, or by excluding most of the light from the slide. With the second slide a certain amount of lustre is perceived.

1.



I II

2.



A very curious effect is produced by combining in the stereoscope two circles, such as I and II, the diameter of I corresponding to the inner diameter of II; the smaller circle is seen to lie in the plane of the paper, while the larger circle is considerably inclined to it.*

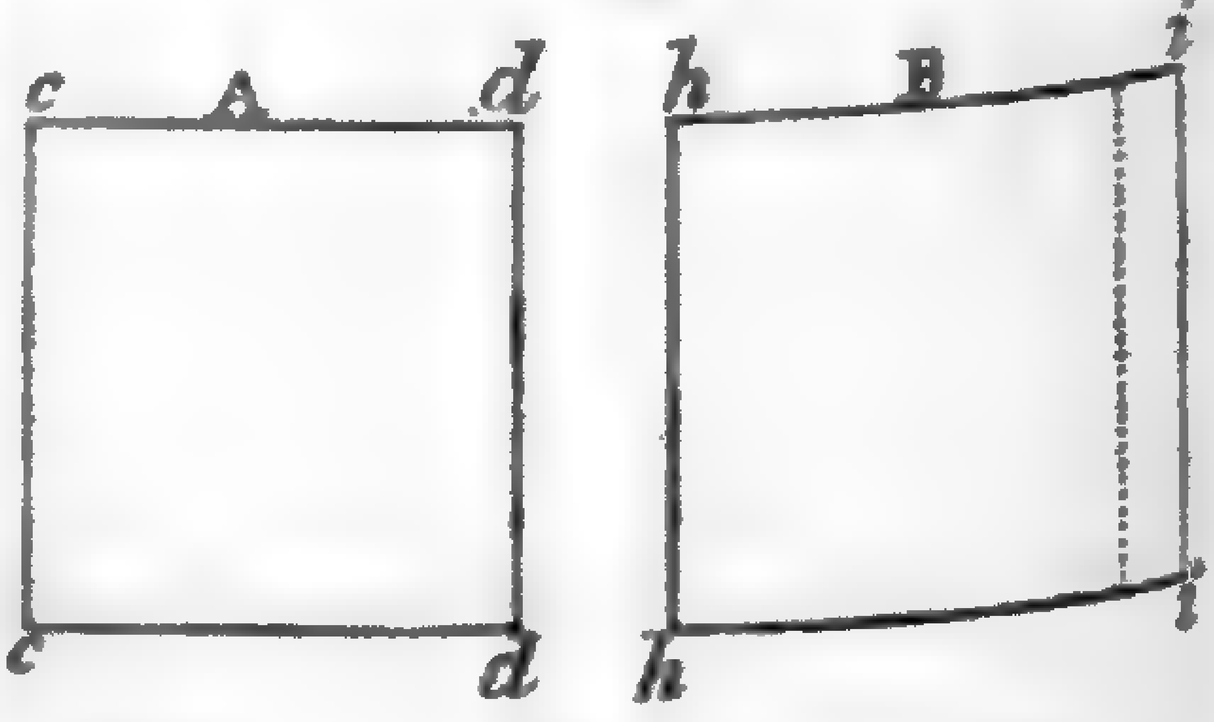
The analysis of this singular fact seems to be as follows: when we place in the stereoscope a slide such as that in fig. 2, the difference in the diameter in the circles being $\frac{1}{10}$ of an inch, combination alternately and rapidly takes place between *a* and (fig. 2) *b*, and between *a* and *b'*, the resultant impression being, according to the principles so ably developed by Prof. Wm. B. Rogers, that of two circles intersecting at a certain angle, the smaller one being situated in the plane of the paper.

Now, when the drawings are made in fine and thick lines, as in fig. 1, the fine line combines alternately with the exterior and with the inner edge of the thick line, and produces the same effect.

2. *On the Production of Lustre in the Binocular Combination of small and large Surfaces.*

By far the most valuable observations on the binocular combination of large and small drawings with which I am acquainted, are those made by Prof. William B. Rogers. The important distinction between the union of drawings differing in size in a horizontal or vertical direction, was first pointed out by him, as well as the fact, that while the former case is normal and of daily occurrence, the latter takes place to a much smaller degree, if at all. Thus he showed that two such parallelograms as A and B in fig. 3 combined readily, and that the resultant image made a considerable angle with the plane of the paper.

3.



* Persons unpracticed in binocular combination will obtain the effect only after several trials.

I combined two such black surfaces as A and B (fig. 3); the ground was white. Now it is evident that when the edges *c c* and *hh* coincide, *dd* cannot coalesce with *ii*, consequently the narrow band, included by the dotted line, appears white to one eye and black to the other; in spite of this, however, the play of the ocular axes was so rapid, and the two combinations so quickly effected, that no lustre on this band was perceptible. Similar experiments with yellow squares on a blue ground gave a like result. When, however, the inequality was in a *vertical* direction, the unmatched band or edge showed lustre with distinctness.

As Dove* has pointed out that the stereoscopic experiments published by me in this Journal† still further confirm his position in opposition to some distinguished physicists, that lustre does not necessarily depend upon an idea of solidity or depth, I will here mention two additional experiments, which would seem to remove the last shadow of doubt on this point. I combined in the stereoscope black surfaces ½ inch square with various tinted papers 1½ inches square, when lustre resulted, although the two figures totally refused to unite into one. Finally, a piece of red or white paper, 1 inch square, was pasted on one side of a blackened stereoscopic slide, which was then placed in the stereoscope. Here but *one figure* was present; to the other eye merely a dark field was presented; consequently, the difficulty of uniting two stereoscopic pictures was not present. After a little trial brilliant lustre was produced, as in the former case. This experiment is somewhat more difficult to make than those previously described by Dove and myself, simply because it is here not quite so easy to divide the attention equally between the two eyes. The lustre then is independent of the idea of depth, and *two* figures are useful merely in enabling the observer the more readily to pay equal attention to the two impressions. The following experiment points to the same conclusion.

3. *Production of Lustre by the convergence of the Ocular Axes.*

In the following beautiful experiment the idea of solidity is not only excluded, but the lustre is seen detatched even from a material surface. An aperture, ½ inch in diameter, is cut in a blackened piece of cardboard, and across the opening a sewing-needle is fastened by a little wax. The card thus prepared is held at a distance of six or eight inches from the eyes, while behind it, at a distance of a foot or more, a sheet of white paper is placed beside one which is blackened. The cardboard is held in such a manner that the aperture appears black to one eye and white to the other; the ocular axes are then converged on the

* Pogg. Annalen, vol. cxiv, p. 165. † Vol. xxxi, May, 1861.

needle, which is attentively regarded. The open aperture now assumes a lustrous appearance, and one is tempted to believe that it encloses a plate of very clear polished glass; but as an instinctive search for minute particles of dust on this imaginary surface fails to detect them, the idea is gradually forced on the mind that it is the *air* itself which now has become lustrous. By shading the black paper the effect is much heightened. Corresponding effects are produced by the use of blue with yellow paper, etc.

Dove suggests,* that the peculiar lustre of the deep blue sky is caused by light from different distances falling on the eye; and I found, in fact, in this experiment, that when a surface of dark blue paper is combined with white or light blue paper, the combination strongly reminded me of the soft lustre of a cloudless sky.

Troy, N. Y., August, 1862.

ART. XIX.—*Tenth Supplement to Dana's Mineralogy;* by GEO. J. BRUSH, Professor of Metallurgy in Yale College.

List of Works, etc.

A. KENNGOTT: Uebersicht der Resultate mineralogischer Forschungen im Jahre 1860. 8vo, pp. 217. Leipzig, 1862.

H. KOPP UND H. WILL: Jahresbericht über die Fortschritte der Chemie, und verwandter Theile anderer Wissenschaften. 8vo, pp. 906. Giessen, 1861.

H. GIRARD: Handbuch der Mineralogie. 8vo, pp. 656. Leipzig, 1862.

F. v. KOBELL: Die Mineralogie—Populäre Vorträge. Frankfurt a. M. 1862.

H. O. LENZ: Mineralogie der alten Griechen und Römer. 8vo, pp. 194. Gotha, 1861.

FRIEDERICH HESSENBERG: Mineralogische Notizen, No. 4. Dritte Fortsetzung. 4to, 44 pp. Frankfurt, 1861. This number of Hessenberg's "Notizen" contains figures and descriptions of crystals of Gypsum from Girgenti; Calcite from Bleiberg, Maderaner-Thal and Ahrnthal; Apatite, Sphene and Perowskite from Pfitsch in Tyrol; American Chrysoberyl; Datholite from Bergen Hill; Haytorite; Fahlerz from Kahl; Barytes from Ober Ostern; Brucite from Texas, Pennsylvania; Orthoclase from Baveno.

A. SCHRAUF: Monographie des Columbit. 8vo, pp. 20, mit 7 Tafeln. Wien, 1861.

H. DAUBER: Ermittelung Krystallographischer Constanten, und des Grades ihrer Zuverlässigkeit (22. Rothbleierz). 8vo, pp. 53, mit 12 Tafeln. Wien, 1860.

PETERS K. F.: Mineralogische Notizen. I. Ein Beitrag zur Entwicklungs-Geschichte des Azurits und des Malachites von Moldava im Banat. II, Ueber Kalcit und die rhomboedrischen Karbonspathe im Allgemeinen. III, Miscellaneen—Neues Jahrbuch für Mineralogie, etc., Jahrgang, 1861, pp. 278–285, 434–458, 655–666.

——— Geologische und Mineralogische Studien aus dem südöstlichen Ungarn, insbesondere aus der Umgegend von Retzbanya. Sitzungsberichte der Wien. Akad. der Wissenschaften, xliii, 385–463, xliv, 81–187.

H. SAINTE CLAIRE DEVILLE: De la présence du Vanadium dans un minerai alumineux du midi de la France. Etudes analytiques sur les matières alumineuses. Ann. de Chimie et de Physique, (3,) lxi, 309.

* Pogg. Annalen, vol. cxiv, p. 167.

H. Sainte Claire Deville: Observations sur la présence de quelques éléments ordinairement tèrsrares dans des substances plus communes. Ann. de Chimie et de Physique, (3), lxi, 342.

——— Du mode de formation de la Topaze et du Zircon. Compt. Rendus, lii, 780.

——— De la production de la Willémite et de quelques Silicates métalliques. Comptes Rendus, lii, 1304.

——— Reproduction de Fer oxydulé, de la Martite, et de la Périclase—Protoxyde de Manganése cristallisé. Comptes Rendus, liii, 199.

H. St. Claire Deville et Troost: De la reproduction des Sulfures métalliques de la nature. Comptes Rendus, lii, 920.

A. Daubrée: Observations sur les Zéolithes formées dans un béton romain par les Eaux thermales de Luxeuil (Haute-Saône). Bull. Soc. Geol., xviii, 108.

——— Betrachtungen und Versuche über den Metamorphismus und über die Bildung der krystallinischen Gesteine. Aus dem xvii. Bande der Mémoires présenté par divers savants a l'Académie des Sciences. Paris, 1860, übersetzt von E. Söchting, Berlin, 1861.

A. Des Cloizeaux: Memoire sur un nouveau Procédé propre à mesurer l'Indice moyen et l'Ecartement des Axes optiques dans certaines substances où cet écartement est très-grand, et sur la Séparation de plusieurs Espèces minérales regardées jus'qu' ici comme isomorphes. Comptes Rendus, lii, 784.

——— Sur les Modifications temporaires et sur une Modification permanente que l'Action de la Chaleur apporte à quelques propriétés optiques du Feldspath orthose. Comptes Rendus, liii, 64.

——— Notice sur les Travaux minéralogiques et géologiques. 4to, pp. 37. Paris, 1861.

A. Delesse: De l'Azote et des Matières organiques dans l'Ecorce terrestre. 8vo, pp. 176. Paris, 1861.

——— Etudes sur le Métamorphisme des Roches. 4to, pp. 95. Paris, 1861.

E. Hitchcock, E. Hitchcock, Jr., C. H. Hitchcock and A. D. Hager: Geology of Vermont. 4to, pp. 988. Claremont, 1861.

J. D. Whitney: Report of a Geological Survey of the Lead Region of the Upper Mississippi. Extracted from the First Volume of the Geological Survey of Wisconsin, pp. 73–424. Albany, N. Y., 1862.

E. Holmes and Charles H. Hitchcock: General Reports on the Geology and Natural History of Maine; comprises 360 pages of the Sixth Annual Report of the Maine Board of Agriculture. 8vo, pp. 464. Augusta, 1861.

A. Winchell: First biennial Report of the progress of the Geological Survey of Michigan, embracing observations on the Geology, Zoölogy and Botany of the Lower Peninsula. 8vo, pp. 339. Lansing, 1861.

Description of Species.

Adamsite.—See Margarodite.

Algodonite [Suppl. V].—Dr. Genth has identified this mineral as occurring with *whitneyite* from Lake Superior (see whitneyite). It is more granular than the associated whitneyite; it has a grayish-white color and metallic lustre, and when polished is almost silver white. The purest of it forms the lining of little cavities as minute crystals, too indistinct to determine their form. Analysis shows that the composition is very nearly that of *algodonite*, although a slight admixture of whitneyite generally gives the arsenic a little too low. Dr. Genth has also analyzed a specimen of algodonite from Cerro de los Seguas (Dept. Rancagua, Chile). The Chile mineral had a density of 7·62; hardness, about that of fluor; color, steel-gray to silver white; fracture, sub conchoidal; brittle; lustre, on fresh fracture, metallic but becoming dull on exposure; associated with cuprite, barytes, malachite, etc. Analysis of the mineral from the two localities gave:

	As	Cu	Ag		
1. Lake Superior,	15·30	84·22	0·32	=	99.84
2. "	undet.	84·10	0·34		
3. "	16·72	82·35	0·30	=	99·37
4. Chile,	17·46	81·82	*tr.*	=	99·28
5. "	16·94	82·33	*tr.*	=	99·27
6. "	16·44	83·11	*tr.*	=	99·55

Nos. 1 and 2 appear to have contained a small admixture of whitneyite. Nos. 3, 5 and 6 give almost exactly the formula Cu_{12} As=As 16 50, Cu 83·50—(this Journal, xxxiii, 192).

Alisonite [Suppl. VII].—F. Field gives a new analysis of this species, in which he found;

S	Cu	Pb		
17·69	53·28	28·81	=	99·78

This agrees very closely with the former analysis, and gives the formula 3€uS+Pb S=S 17·78, Cu 53·34, Pb 28·88.—(*Quar. Jour. Chem. Soc.*, xiv, 160.)

Allanite [p. 208, I—VI, VIII].—D. M. Balch has found *orthite*, associated with quartz and feldspar, at Swampscot, Mass. It is massive; color, jet black; streak, gray; G.=3·69–3·71 at 18° C. B.B. fuses to a black blistered glass; with borax and soda gives reactions for iron and manganese. Composition:

	Si	Al	Fe	Ce	Y	Ca	Mg	Na	H
1.	33·31	14·73	15·82	21·94	1·32	7·85	1·25	undet.	1·49=97·71
		Al Fe							
2.	32·94	33·60		20·71	1·32	7·87	1·47	"	1·49=99·40

The mineral in its natural state is decomposed by chlorhydric acid, but after ignition is not affected by it. It very nearly corresponds in composition with the orthite from Hitteroe—(this Journal, [2], xxxiii, 350).

Analysis of *allanite* from Franklin, New Jersey, by T. S. Hunt (Proc. Bost. Soc. Nat. Hist., viii, 57). The mineral is associated with feldspar, and was found by Dr. Jackson, in the old Magnetic Iron Mine at Franklin. Sp. Gr.=3·84. Partially decomposed by hot chlorhydric acid, with separation of flocculent silica. Composition:

Si	Al	Fe	Ce	La Di	Ca	Mg	Mn	Ign.
30·20	18·05	18·25	16·60	6·90	11·76	1·70	*tr.*	1·30

Alunite [p. 388, V].—Analyses of native *alunite*, from Tolfa, Italy, and Muzsai, Hungary, by A. Mitscherlich.—(*Jour. pr. Chem.*, lxxxiii, 464.)

	Al	S	Ca	Ba	K	Na	H
Tolfa,	36·83	38·63	0·70	0·29	8·99	1·84	12·72
Muzsai,	39·15	36·93	0·49	0·19	10·67	—	12·57

Mitscherlich considers that the rational composition is best expressed by the formula K S+Al S^3+2Al H^3, as the water is not expelled below the temperature of boiling sulphur, and moreover, when expelled, the residue consists of anhydrous alum and alumina.

Anglesite [p. 370, II, III].—F. Field has examined a black amorphous variety of sulphate of lead, from a mine near Coquimbo, Chile. It occurred in large black masses, in the centre of which a small vein of galena was running. It had a black earthy appearance, and was without metallic lustre. The argentiferous galena forming the nucleus of the mass, contained appreciably more silver than the exterior sulphate. G.=6·20. Composition:

Pb S	Fe	Ag		
96·74	3·16	*tr.*	=	99·90

(*Quar. Jour. Chem. Soc.*, xiv, 156.)

Antozonite.—See Fluor.

Aphrosiderite [p. 297, I].—Erlenmeyer gives analyses of a mineral resembling *aphrosiderite*, from two iron mines; one at Muttershausen, in Nassau, the other at Balduinstein. The streak of the mineral from both localities is apple-green.

	$\dddot{\mathrm{Si}}$	$\bar{\mathrm{Al}}$	$\bar{\mathrm{Fe}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{H}}$
1. Muttershausen, G.=2·99	25·72	20·69	4·01	27·79	11·70	10·05=99·96
2. Balduinstein, G.=3·01	25·99	——	4·13	27·60	11·93	10·13

Corresponding very closely with the *aphrosiderite* analyzed by v. Hauer, from Upper Styria (Supp. I).—(Kopp's *Jahresbericht*, 1860, 773.)

Apophyllite [p. 304, V].—Analysis of the pink *apophyllite*, from Andreasberg, by H. Stölting:

$\dddot{\mathrm{Si}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$	
51·73	25·02	5·10	15·73	= 99·58

No fluorine is given.—(*B. and H. Zeitung*, xx, 267.)

Arsenical-Antimony [p. 22].—An interesting variety of this mineral, from the Ophir Mine, Nevada Territory, has been described and analyzed by F. A. Genth. Occurs in reniform, finely crystallized, somewhat radiated masses. Color on fresh fracture between tin-white and iron-black, but grayish-black on exposure. Composition, after excluding impurities, As 90·82, Sb 9·18—(this Journal, [2], xxxiii, 190).

Arsenolite [p. 139,].—Dr. Genth has found *arsenolite*, associated with arsenical-antimony, in specimens, from the Ophir Mine, Nevada Territory—(this Journal, [2], xxxiii, 190).

Automolite.—See Spinel.

BIHARITE [*K. F. Peters Ber. Wien. Akad.* xliv, 133].—Peters gives this name to a mineral from Werksthal near Retzbanya, which has previously passed under the name of *agalmatolite*. It is a massive, compact micro-crystalline substance associated with fine granular limestone. The mass has a greasy feel and adheres somewhat to the tongue. It is slightly brittle, fracture uneven to splintery conchoidal. H.=2·5. G.=2·737 (yellow variety). Color yellow and green—from brown and cloudy wine-yellow to leek green. Small splinters are transparent, all varieties translucent. Streak white. Lustre, greasy to pearly, with polarization microscope shows double refraction. Rubbed with silk gives positive electricity. B.B. in closed tube yields water and becomes white or grayish white. The green variety is infusible, and the yellow variety fuses only on the edges. With cobalt solution gives first a rose-red, and after longer heating, a violet color. Does not gelatinize with acids. A specimen of an apparently homogeneous variety of a wine-yellow to oil-green color analyzed by M. Soltesz gave,

$\dddot{\mathrm{Si}}$	$\bar{\mathrm{Al}}$	$\bar{\mathrm{Fe}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{H}}$	$\ddot{\mathrm{C}}$
39·80	12·83	*tr.*	6·68	27·49	4·63	*tr.*	4·24	2·05=97·72

The carbonic acid was due to limestone mechanically mixed with the mineral. Peters remarks that, he "is far from considering this silicate as a well characterized mineral." To establish this point, he says "that it would be first necessary to have analyses of all the different varieties, still in order to induce further investigation, he names it *biharite*, after the mountain in which it occurs." We feel justified in remarking, that if the mineral is not "well characterized," the author is somewhat premature in giving it a new name. We question very much the propriety of adding a new name to science, without full and just grounds, under the plea of inducing further investigation. It is gaining the credit of naming a species, while throwing the burden of investigation on others.

Bismuth [p. 20, VIII].—A remarkable vein, containing metallic bismuth, has been opened at the Atlas Mine, in Devonshire. The vein is three feet in width, and the bismuth constitutes one-sixteenth of the whole mass, having a value of £300 to the fathom.—(*Dingler's Polytechnisches Journal*, clix, 76.)

Boracite [p. II, III–VIII].—Analysis of stasfurthite, by Kromayer (Ludwig, in

Kopp's *Jahresbericht*, 1859, 816). The mineral was washed with cold water, to free it from adhering chlorid of magnesium. The insoluble portion gave:

Mg Cl	$\dot{M}g$	$\dot{H}$	$\dddot{B}$[a]
9·97	24·93	6·20	58·90

[a] By difference.

giving the formula $2(\dot{M}g^3\dddot{B}^4+\dot{H})+MgCl, \dot{H}$ or two equivalents more of water than obtained by Heintz and Potyka.

Boronatrocalcite [see Hayesine, p. 394, V, VIII].—H. How has given the name *cryptomorphite* to a hydrous borate of lime and soda, which is found in gypsum, near Windsor, Nova Scotia (this Journal, [2], xxxii, 9). It occurs in cakes, or rounded masses, of the size of a small pea or bean, laying between crystals of glauber salt and gypsum. Color, white; lustreless; soft, H.=1, but coherent; tasteless; slightly tough between the teeth. B.B. fuses easily to a clear bead; insoluble in water; soluble in chlorhydric acid. On exposure to the air, loses 18·36 per cent of water. With a magnifying power of 350 diameters, Prof. Robb found the mineral to be distinctly crystalline, with a rhombic structure, and differing in form very materially from the natro-borocalcite found at the same locality. Composition of the air-dried mineral:

$\dot{C}a$	$\dot{N}a$	$\dddot{S}$	$\dot{M}g$	$\dot{H}$	$\dddot{B}$
14·21	7·25	3·98	0·62	19·96	53·98

Assuming the magnesia and sulphuric acid to be accidental, and deducting the magnesia as $\dot{M}g\,\dddot{S}+7\dot{H}$, and the remaining sulphuric acid as $\dot{N}a\,\dddot{S}$, How obtains $\dot{C}a$ 15·55, $\dot{N}a$ 5·61, $\dot{H}$ 19·72, $\dddot{B}$ 59·10, corresponding to the formula $\dot{N}a$, $3\dot{C}a$, $9\dddot{B}+12\dot{H}$, or $\dot{N}a\dddot{B}^4+\dot{C}a^3\dddot{B}^5+12$ aq. [We have placed this mineral under *boronatrocalcite*, as, according to our view, this name expresses sufficiently well its composition and relations in the classification of hydrous borates. If we were to calculate formulæ for all of the published analyses of hydrous borates of lime and soda, we should have at least a dozen different compounds represented. No one believes that these are all distinct mineral species, and until repeated analyses are made, which prove the definite and invariable composition of the mineral from any given locality, we may well hesitate before creating or adopting any more new species. The hydrous borates of lime and soda have already rather an excess of synonyms; for the lime borate we have hayesine, borocalcite and hydroborocalcite; for the lime and soda borate: boronatrocalcite, ulexite, tinkalzite, tiza, natroborocalcite, and now cryptomorphite. That there are two distinct species, hayesine and boronatrocalcite, does not admit of a doubt, but as the composition of neither of these is definitely settled, we are not yet willing to admit that these names, as at present applied, each represent three or four distinct mineral species.—G. J. B.]

Bournonite [p. 80, V].—F. Field has found this species at a mine near Huasco, in northern Chile. The specimen was crystallized. H.=2·5, G.=5·80. It resembled in every respect the *bournonite* from Cornwall. Field gives analyses of both the Chilean and Cornish minerals, with the following results:

	S	Sb	Pb	Cu		
Huasco,	20·45	26·21	40·76	12·52	=	99·94
Cornwall,	20·30	26·30	40·80	12·70	=	100·10

These analyses correspond in a most remarkable manner with Rose's analysis of the Pfaffenberg *bournonite*.—(*Quar. Jour. Chem. Soc.*, xiv, 158.)

Brucite [p. 133, I, II–IX].—R. Hermann has given the name *Texalite* to the hydrate of magnesia from Texas, Pennsylvania, and has attempted to show that its form was monoclinic, and that $\dot{M}g\dot{H}$ was consequently dimorphous (*Jour. für prakt. Chem.*, lxxxii, 368). The writer has already proved, from the examination of a large number of crystals, that this conclusion was erroneous (this Journal, xxxii, 94), and that the form of the Texas mineral is rhombohedral, as already determined by Dana, and, previous to the publication of Hermann's paper, it had also been determined by Kenngott and G. Rose (*Zeitschrift der Geol. Gesellschaft*, xiii, 178). The paper by Rose had not then been received here, or it would have been quoted in answer to Hermann. The crystals examined by Rose and myself were hexagonal prisms, with rhombohedral planes R and $-\frac{1}{2}R$. Since the publication of these results, Hessenberg has published, in No. 4 of his "Notizen," an examination of the crystalline form of this species, which also shows it to be rhombohedral. To this we may add, that Dr. Auerbach found that its optical properties were those of a rhombohedral substance, an observation which we are able to substantiate.

With such an accumulation of facts from five different authorities, it may safely be assumed that texalite does not differ from ordinary rhombohedral *brucite*.

An analysis of the Texas mineral gave Hermann:

$\dot{\text{Mg}}$	$\dot{\text{Mn}}$	$\dot{\text{H}}$
68·87	0·80	30·33

Calamine [p. 313, II–VII].—The name *wagite* has been given by Radoszkovski, to a concretionary silicate of zinc from Nijni-Jagurt, in the Ural (*Comptes Rendus*, liii, 107). It occurs in concretionary crusts, which, when examined by the magnifier, show indistinct crystals. Color, light blue to green. H.=5, Sp. gr.=2·707. Soluble in acids. Composition:

	$\dddot{\text{Si}}$	$\dot{\text{Ca}}$	$\dot{\text{Zn}}$	$\dot{\text{H}}$	$\dot{\text{Cu}}\,\dot{\text{Fe}}$	
	26·00	1·55	66·90	4·70	*tr.*	= 99·15
Oxygen,	13·87	·44	13·21	4·18		

giving the ratio for $\dddot{\text{Si}}$, $\dot{\text{Zn}}$, H, 3 : 3 : $1\frac{1}{3}$. The author, by an error in calculation makes the ratio 3 : 3 : 1; the composition and ratio are so near those of Calamine, that for the present we may safely consider wagite a variety of this species. The, only anomalous property is the specific gravity, which is considerably less than that given for Calamine.

Cancrinite [233, II–VIII].—G. Tschermak has examined *cancrinite*, from Ditro in Siebenbürgen. It is found in loose masses, with sodalite, elæolite and orthoclase. Color, pale flesh-red; cleaves perfectly, yielding hexagonal prisms. H.=5–5·5, G.=2·42. Composition:

$\dddot{\text{Si}}$	$\dddot{\text{Al}}$	$\dot{\text{Ca}}$	$\dot{\text{Na}}$	$\dot{\text{H}}$	$\ddot{\text{C}}$	
37·2	30·3	5·1	17·4	4·0	5·2	= 99·2

not differing materially from the composition of cancrinite from the Ural and from Maine.—(*Ber. Wien. Akad.*, xliv, 134.)

Cervantite [p. 141].—T. L. Phipson has examined a native oxyd of antimony from Borneo, which is identical with this species (*Comptes Rendus*, lii, 752). It is associated with stibnite, and occurs as a compact crystalline substance, of a yellowish or reddish-white color and yellowish-white streak.

Isolated crystals, of half an inch in length, were also found, having the form of the right-rhomboidal prism, terminated by two planes with modifications; they had a pearly lustre, and were horizontally striated. In the closed tube, the mineral was non-volatile and unaltered, thus distinguishing it from SbO_3. B.B. infusible, thus differing from SbO_5. Pure specimens were entirely volatile in the reducing flame, but unaltered in the oxydizing flame. These reactions, in connexion with the following analysis, show the mineral to be SbO_4. With soda gives metallic antimony. The specimen analysed contained stibnite, sulphur, oxyd of iron and alumina as impurities. Composition:

	SbO_4	$\dot{\text{H}}$	$\dddot{\text{Fe}}\,\dddot{\text{Al}}$	$\dddot{\text{Si}}$, S, etc.	
G.=4·64–4·68	65·00	3·75	10·00	21·25	= 100·00

[Phipson considers the water as combined with the antimony, giving the formula SbO_4, HO, and refers the mineral to Beudant's species *stibiconite*, but as we infer from his description that the pure mineral was unaltered in the closed tube, we may assume that the water was combined with the iron, alumina, and other impurities mentioned.—G. J. B.]

Chabazite [p. 319, II].—Analysis of *chabazite* from Oberstein gave G. Schrœder:

$\dddot{\text{Si}}$	$\dddot{\text{Al}}$	$\dot{\text{Ca}}$	$\dot{\text{Ba}}$	$\dot{\text{Sr}}$	$\dot{\text{Na}}$	$\dot{\text{K}}$	$\dot{\text{Mg}}$	$\dot{\text{H}}$
50·19	17·45	7·13	0·48	0·32	2·12	0·62	*tr.*	22·09=100·40

—Kenngott, *Uebersicht*, 1860, 56.

Chlorite [p. 294, IV, V–VIII,].—Genth has described a chlorite-like mineral from Webster, N. C., which he considers a result of the alteration of chrysolite. It occurs in what appear to be rhombohedral plates, and the crystals, though indistinct, present triangular basal and rhombohedral planes. Cleavage, basal and highly perfect. H=2·5. Color, dark bluish to brownish-green; translucent. B.B. exfoliates slightly and becomes silver-white. Infusible. The material for analysis was too small to have it of uniform color.

	$\ddot{\mathrm{Si}}$	$\dddot{\mathrm{Al}}$	$\dddot{\mathrm{Cr}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Ni}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{K}}$	Ign.
1.	31·15	13·70	4·16	4·83	0·16	undet.	0·17	undet.	3·29
2.	31·75	12·45	undet.	4·94	undet.	43·10	undet.	0·06	undet.
Mean,	31·45	13·08	4.16	4·88	0·16	43·10	0·17	0·06	3·29=100·35

These results place the mineral near pyrosclerite and chlorite. The small amount of water is remarkable, especially when taken in connection with the anhydrous talc from the same locality—(this Journal, [2], xxxiii, 200).

Shepard's *rastolyte*, from Monroe, New York, is shown by Pisani to be a *ferruginous chlorite* (*Comptes Rendus*, liv, 468). Pisani observes, that although the mineral is somewhat acted upon, it is not entirely decomposed by acids. After deduction of the iron pyrites with which it is intimately associated, the composition was found to be:

$\ddot{\mathrm{Si}}$	$\dddot{\mathrm{Al}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{H}}$	
34·98	21·88	28·44	6·24	9·22	= 100·76

All the iron was in the state of protoxyd. A former analysis by Shepard made the composition near that of stilpnomelane (see Suppl. IV); but this analysis is undoubtedly incorrect, as Pisani has proved that the mineral is only partially decomposed by acid, so that results obtained from an attempted decomposition by acids must be erroneous. The physical properties and chemical composition of the mineral render it extremely probable that it is an impure variety of chlorite.

Chrysocolla [p. 309, II–VIII].—F. Field has published an interesting paper on the silicates of copper from Chile (*L. E. D. Phil. Mag.*, [4.] xxii, 361). A variety from Tambillos, near Coquimbo, having a turquoise-blue color, perfectly amorphous and opaque, gave on analysis: $\ddot{\mathrm{Si}}$ 28·21, $\dot{\mathrm{Cu}}$ 39·50, $\dot{\mathrm{H}}$ 24·52, $\dddot{\mathrm{Fe}}$ 2·80, $\dddot{\mathrm{Al}}$ 4·97. Excluding the iron and alumina, as foreign to the mineral, we have $\ddot{\mathrm{Si}}$ 30·59, $\dot{\mathrm{Cu}}$ 42·83, $\dot{\mathrm{H}}$ 26·58 or $\dot{\mathrm{Cu}}\,\ddot{\mathrm{Si}}+3\dot{\mathrm{H}}$. Other analyses are given of substances which do not appear to be definite compounds.

Chrysolite [p. 184, I–IV, VI].—F. A. Genth has analyzed two varieties of *chrysolite*, occurring in talc-slate, at Webster, Jackson Co., N. Carolina: 1. pale grayish-green, granular and very friable, G=3·28 (12° C); 2, less friable, of darker yellowish olive-green color, G.=3·2·52.

	$\ddot{\mathrm{Si}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Ni}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	Chrome-iron and quartz.	Ign.
1.	41·89	7·39	0·35	49·13	0·06	0·58	0·82=100·21
2. (*a*,)	40·37	7·39	0·50	——	——	1·27	0·50
2. (*b*,)	40·74	7·26	0·39	49·18	0·02	1·83	0·76=100·18

with traces of alumina, oxyds, of cobalt and manganese, associated with chrome-iron, talc, serpentine, and a mineral resembling pyrosclerite. Dr. Genth expresses the opinion, that the specimens give evidence that chrysolite is probably the mineral from which talc-slate, and many of the serpentines have been formed—(this Journal, [2], xxxiii, 199).

For analysis of altered olivine from Ihringen, in Breisgau, by Lewinstein, see Kopp, *Jahresbericht*, 1860, 757.

Clinochlore [p. 293, I, II, V–IX].—Analysis of *clinochlore* from Achmatowsk, by H. Struve:

$\ddot{\mathrm{Si}}$	$\dddot{\mathrm{Al}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{H}}$	
31·64	13·54	5·83	36·20	0·05	12·74	= 100
31·52	13·96	6·12	35·68	0·05	12·67	= 100

Mat. Min. Russlands, iii, 236, in Kopp's *Jahresbericht*, 1860, 772.

COPIAPITE [p. 387, I, III, IV].—A new analysis of *fibroferrite*, from Chile, by F. Field, (*Quar. Jour. Chem. Soc.*, xiv, 156,) shows that this mineral loses water on exposure to the air. The mineral is found in botryoidal masses, each rounded nodule being built up of innumerable silky fibres diverging from a centre, and having a golden green color. An analysis gave the formula $\ddot{\overline{F}}e\ \dddot{S}^2+10\dot{H}$. On exposure to the air for two weeks it lost two equivalents of water; a longer exposure of many months produced no further change in composition. Heated at 212° F. it was converted into $\ddot{\overline{F}}e\ \dddot{S}^2+3\dot{H}$.

COPPER [p. 17, IV, VI–IX].—The pseudomorphous crystals of copper after aragonite, described by Kenngott (Suppl. V), have been examined by D. Forbes, (*Quar. Jour. Geol. Soc.*, London, xvii, 45). Crystals are found in the copper mines of Corcoro, in Peru. They are hexagonal; some consist entirely of copper, while others have a nucleus of carbonate of lime, from which Forbes infers that the pseudomorphs have been formed by the action of a solution of copper on crystals of carbonate of lime, and by some subsequent chemical change the carbonate of copper thus formed has been reduced to the metallic state. An analysis of one of the crystals, by Kroeber, gave:

Cu	$\dddot{S}i$	Ag	Fe*	Insol.		
98·605	0·015	*tr.*	1·376	0·004	=	100·00

* By difference.

F. Alger has described what he considers to be a rhombohedron of copper, from Copper Falls Mine, (Lake Superior). It is associated with rhombohedral carbonate of lime, and the copper is thought by Alger to be pseudomorphous of calcite. Dr. Jackson suggests that the crystal may be a cube, which slightly distorted, gives it a rhombohedral aspect (*Proc. Bost. Soc. Nat. Hist.*, viii, 171).

COPPER GLANCE [p. 46, 505].—Dr. Genth has made a very elaborate series of analyses of the so-called *harrisite*, from the East Tennessee Mine, Polk Co., Tenn., which entirely substantiate his former opinion, that "harrisite was copper-glance pseudomorphous after galena." Dr. Genth mentions that Dr. Torrey first discovered specimens of *harrisite* from Canton Mine, which contained a nucleus of *unaltered galena*, and soon after Mr. Trippel, of the Tennessee Copper Mines, discovered this same pseudomorph at the East Tennessee Mine, at which latter place it is found in a feldspathic rock, associated with chalcopyrite, pyrites, blende, garnet and lime-epidote. The Tennessee specimens have a color between dark lead gray and bluish black. They frequently contain a nucleus of almost unaltered galena; some specimens are almost pure copper-glance, while others are intermediate between copper-glance and galena, as shown by the analyses. The rational composition deduced from the analyses of seven specimens gave the following:

	1.	2.	3.	4.	5.	6.	7.
Galena,	97·41	26·93	14·50	13·14	3·29	1·24	0·47
Silver-glance,	0·83	0·24	0·57	0·83	1·26	0·23	0·18
Covelline,	1·41	——	5·02	4·11	4·70	2·20	9·03
Copper-glance,	——	70·26	78·82	81·05	89·89	93·80	80·70
Pyrites,	0·43	3·20	1·09	0·86	0·86	1·39	8·81

Analysis 2 by Trippel, the others by Genth. The author queries whether alisonite, $3Cu_2S+PbS$, and cuproplumbite $Cu_2S+2PbS$ may not also prove to be pseudomorphs of copper-glance after galena in an unfinished condition—(this Journal, [2], xxxii, 194).

COPPER-NICKEL [p. 52, VI–VIII].—Analysis of *copper-nickel* from Andreasberg by H. Hahn (*B. and H. Zeitung*, xx, 281):

Ni	Co	As	S	Fe	Insol.		
23·75	10·81	50·94	5·69	0·83	8·80	=	100·82

Cryptomorphite.—See BORONATROCALCITE.

DATHOLITE [p. 334, I–IV, VI, VIII].—G. Tschermak has analyzed the transparent crystallized *datholite*, from Toggiana. He found $\dddot{S}i$ 38·2, $\dot{C}a$ 34·9, $\dot{H}$ 5·7, $\dddot{B}$ (by loss) 21·2. G.=3.—(*Kenngott, Uebersicht*, 1860, 57.)

The peculiar massive *datholite* described by J. D. Whitney (this Journal, [2], xxviii, 13), has been further examined by A. A. Hayes (*Proc. Bost. Soc. Nat. Hist.*, viii, 62). The specimens examined were from the Isle Royale, Quincy, Marquette, Minnesota and "Ash-bed" mines. The mineral is compact, resembling some varieties of Wedgewood-ware. H.=5·5. Other physical properties the same as already given by Whitney. Analyses of two specimens gave:

$\dddot{S}i$	$\dddot{B}$	$\dot{C}a$	$\dddot{F}e\dddot{A}l$	$\dot{C}u$	$\dot{H}$	quartz.		
38·32	22·64	32·82	1·04	0·80	3·98	0·80	=	99·68
37·92	22·16	33·64	—	—	3·96	2·08	=	99·76

It contains less water than is given for crystallized datholite, and Dr. Hayes suggests the possibility that in former analyses the water may have been given too high, owing to loss of boric acid by exposure to intense ignition.

[Dr. Hayes calls attention to this mineral as being sometimes confounded with pectolite. It is quite remarkable that datholite, pectolite and wollastonite are all found at Lake Superior in compact masses, differing entirely in appearance from these minerals as found at other localities. The compact datholite is of frequent occurrence; during the past summer I observed it at many of the mines in the Portage Lake, Keweenaw and Ontanagon districts. Very fine specimens occur at the Superior Mine near Ontanagon.—G. J. B.]

Dechenite [p. 362, III, IV, VIII].—The *rhombic vanadinite* from Kappel in Carinthia, described by Zippe, has been analyzed by G. Tschermak (*Wien. Akad. Ber.*, xlvi, 157).

	$\dot{P}b$	$\dddot{V}$
G.=5·83.	54·3	45·7 = 100.

A trace of zinc was also found. Tschermak considers it as identical with *dechenite*.

DELEMINZITE—*Breithaupt, Berg und Hüttenmännische Zeitung*, xxi, 98.—Breithaupt gives this name to what he considers to be a new form of sulphid of silver, differing from silver-glance and akanthite. It is isomorphous with copper-glance. The angle of the prism was determined to be 116°. G.=7·02. Named after Deleminzin, the ancient name for Freiberg. Locality of the mineral not stated, but it is probably from Freiberg.

Dianite [Suppl. IX].—Damour and Deville have shown that v. Kobell's dianic acid is identical with hypocolumbic acid, consequently this mineral can no longer be considered as distinct from tantalite.—(*Comptes Rendus*, liii, 1,044.)

Domeykite [p. 36, V].—F. A. Genth confirms the observations of Hunt and Whitney in regard to the occurrence of a mixture of domeykite and copper-nickel in the ore from Michipicoten Island. He also gives analyses of the domeykite recently found on the Sheldon location at Portage Lake. It is massive; hardness, a little below that of fluor. G. at 16° C. 7·75. Color, on fresh fracture, tin-white to steel-gray, quickly tarnishing, first into yellow and pinchbeck, afterwards showing pavonine tints, and finally becoming brown. Lustre, metallic when fresh, but dull after exposure. Fracture uneven, subchonchoidal. Associated with quartz and arseniate of copper. Analyses:

	As	Cu		
1.	29·25	70·68	=	99·93
2.	29·48	70·01	=	99·59

Analysis I contained 0·55, and II, 6·71 pr. ct. quartz. Excluding the quartz, they give the formula Cu^6As=As 29·25, Cu 71·68—(this Journal, xxxiii, 193).

Analysis of *domeykite* from the Corocora Copper Mines, by D. Forbes (*Quar. Jour. Geol. Soc.*, xvii, 44):

Cu	Ag	As
71·13	0·46	28·41

It was found in the form of gray metallic grains, disseminated in sandstone.

Dufrenite [p. 427, IV].—F. Pisani has analyzed *dufrenite*, from Rochefort-en-Terre, (Morbihan, France,) where it occurs in dark green kidney-shaped masses, with limonite and cacoxene (?). Composition:

$\dddot{P}$	$\bar{F}e$	$\bar{A}l$	$\dot{H}$	
28·53	54·40	4·50	12·40	= 99·83

giving the oxygen ratio for $\dddot{P}$, $\bar{F}e$, $\dot{H}$, 10 : 12 : 7, or $2(\bar{F}e\ \bar{A}l)^2\dddot{P}+7\dot{H}$.—*Comptes Rendus*, liii, 1020.

Engelhardite.—See ZIRCON.

EPIDOTE [p. 206, II–VII, IX].—Dr. Genth has described an interesting variety of *lime epidote*, from the Polk County Mine, Tennessee. It occurs in large but indistinct crystals, lengthened parallel to *ii*, which plane is best developed and can be seen on every crystal; some crystals also show the planes 1*i* and ½*i*. Cleavage very distinct parallel to *ii*. The color is gray, with a bluish-green or greenish-brown tint. (Some specimens are white, with a tinge of pink.—G. J. B.) G.=3·344. The larger crystals are frequently intermixed with chalcopyrite, pyrites and quartz. Analyses No. 1, by Genth, No. 2, by Trippel, of a coarse grained, confusedly crystalline variety, partially decomposed, and associated with blende, harrisite, garnet, etc.

	$\ddot{S}i$	$\bar{A}l$	$\bar{F}e$	$\dot{M}n$	$\dot{C}a$	$\dot{M}g$	$\dot{C}u$	$\dot{K}$	Ign.
1.	40·04	30·63	2·28	0·19	25·11	*tr.*	0·24	—	0·71=99·20, Genth.
2.	43·20	29·60	2·88	——	22·72	0·56	——	*tr.*	0·26=99·22, Trippel.

Other partial analyses are given—(this Journal, [2], xxxiii, 197).

FELDSPAR [p. 228, I–III, IX].—S. D. Hayes has investigated the properties of fused feldspar (*Pogg. Ann.*, cxiii, 468). His results show that feldspar suffers no material change in its composition by fusion. [It is well known that feldspar is found as a furnace-product.—G. J. B.]

For analyses of *orthoclase*, from Lauterberg and Holzemmenthal, made in the Clausthal Laboratory, see *B. und H. Zeitung*, xx, 265. Analysis of *glassy feldspar*, from Löwenburg, by G. vom Rath, *Zeitschr. Geol. Gesellsch.*, xii, 44. For other analyses, see Kenngott, *Uebersicht*, 1860, 63–65.

FICHTELITE [p. 472, V].—T. E. Clark shows the crystals of this resin to be monoclinic. The crystals obtained were from a solution in alcohol and ether (*Ann. d. Chem. u. Pharm.*, cxix, 226).

FLUOR [p. 94, II].—The fetid *fluor* from Wölsendorf, in the Palatinate, in which Schafhäutl thought to have discovered hypochlorite of lime (Min. 94), has been examined by Schrötter, (*Sitzungsber. Acad. d. Wissensch., Wien*, xli), who announces that the so-called hypochlorous acid is ozone. More recently the same variety of fluor has been examined by Schönbein, and, according to his views, the so-called ozone is antozone (*Jour. prakt. Chem.*, lxxxiii, 95). Schönbein estimates that the mineral contains $\frac{1}{5000}$ part of its weight (·02 pr. ct.) of this substance, and suggests that this variety of fluor should be called *antozonite*. This very convenient designation should not be received into mineralogical nomenclature as a synomym of fluor, much less as the name of a new species.

FREIESLEBENITE [p. 99, III, IV].—A. Reuss announces the discovery of this rare mineral, at Przibram, in Bohemia. It is found in isolated crystals, from two to six lines in length; usually the crystals are twined. Prismatic cleavage, perfect; fracture, uneven to sub-conchoidal. H.=2·53. G.=6·23. Color steel-gray to blackish-gray. B.B. decrepitates and gives reactions for sulphur, antimony, lead and silver. Analysis by Von Payr:

Sb	S	Ag	Pb	Fe	
27·11	18·41	23·08	30·77	0·63	= 100·00

Lotos, 1859, p. 51–56, in *Jahrb. Min*, 1860, 579.

Fournetite.—See TETRAHEDRITE.

GALENA [p. 39, II–IV, VII–VIII].—Breithaupt has examined the so-called pseudomorphs of galena, after pyromorphite from Bernkastel, on the Mosel, and concludes that they are not pseudomorphs, but true hexagonal prisms of sulphid of lead. He finds that they possess no trace of cubic cleavage, but that they have a perfect basal cleavage and an imperfect prismatic cleavage. The crystals often occur with pyromorphite. Some specimens of stalactitic sulphid of lead, examined by Breithaupt, were also found to have this peculiar cleavage. Breithaupt considers that the low specific gravity of the crystals, 6·82 to 6·87, is remarkable, but he gives no chemical analysis to prove that substance he examined was pure sulphid of lead; it may have contained unaltered *pyro*morphite. He proposes the name *sexangulite* for this variety of galena (*B. and H. Zeitung*, xxi, 99).

For Dr. Genth's paper on copper-glance, pseudomorphous of *galena*, see COPPER-GLANCE.

Gamsigradite.—See HORNBLENDE.

GARNET [p. 190, I–IX].—Analysis of green garnet, from serpentine at Dobschau in Hungary, by Tschermak: $\dddot{\text{Si}}$ 38, $\dddot{\overline{\text{Fe}}}$ 28, $\dddot{\overline{\text{Al}}}$ 3, $\dot{\text{C}}\text{a}$ 30, $\dot{\text{M}}\text{g}$ 2=101. G=3·72.—*Kopp's Jahresbericht*, 1860, 766.

GLAUBERITE [p. 374].—Pisani has found a brick-red friable and resinous-like variety of *glauberite*, associated with polyhalite and anhydrite, in common salt, at Varengeville, near Nancy. Composition: $\dot{\text{N}}\text{a}\,\dddot{\text{S}}$ 50·50, $\dot{\text{C}}\text{a}\,\dddot{\text{S}}$ 48·78, clay 0·40=99·68.—(*Comptes Rendus*, li, 731, in Kopp's *Jahresbericht*, 1860, 788.)

Glossecollite.—See HALLOYSITE.

GOLD [p. 7, I, II, V–VII, IX].—O. C. Marsh, in a paper on the Gold of Nova Scotia, gives analyses of gold from Tangier and Lunenburg:

		Au	Ag	Cu	Fe		
Tangier,	G.=18·95	98·13	1·76	·05	*tr.*	=	99·94
Lunenburg,	G.=18·37	92·04	7·76	·11	*tr.*	=	99·91

A specimen from Lawrencetown had a density of 18·60, indicating a composition between that of the Tangier and the Lunenburg specimens. The Tangier gold is remarkable for its purity, being only surpassed in this respect by that from Schabrowski (this Journal, xxxii, 399).

F. A. Genth has found Gold pseudomorphous of *aikinite*. The exact locality of the specimen was doubtful, but was stated to be from Georgia. A portion of the aikinite was unaltered, but it was mostly converted into the well-known pseudomorph, a cupreous carbonate of bismuth. This latter was found in slender needles, of different degrees of purity; lustre, waxy; color, pistachio or oil green; when earthy, greenish-white. In the centre of many of the crystals was bright yellow gold, of a high degree of fineness, in some cases distinctly showing the rhombic form of the original mineral (this Journal, [2], xxxiii, 190).

J. Tennant describes a mass of gold found at Bakery Hill, Ballarat, in Australia, in 1858, which weighed 2 217 ounces, or 184 pounds 8 ounces. It was melted in London, in September, 1859, and yielded £8,376 10s. 10d. sterling of Gold.—(*Pogg. Ann.*, cxii, 644, *Brit. Assoc. Report*, 29th Meeting, p. 85.)

GYROLITE [p. 305, I].—H. How has discovered *gyrolite* near Margaretville, Nova Scotia. It occurs imbedded in crystalline apophyllite in spherical concretions of pearly lustrous plates, varying in size from a pin's-head to nearly half an inch in diameter. Composition:

$\dddot{\text{Si}}$	$\dot{\text{C}}\text{a}$	$\dddot{\overline{\text{Al}}}$	$\dot{\text{M}}\text{g}$	$\dot{\text{K}}$	$\dot{\overline{\text{H}}}$		
51·90	29·95	1·27	0·08	1·60	15·05	=	99·85

giving the formula, $\dot{\text{C}}\text{a}\,\dddot{\text{Si}}+1\frac{1}{2}\dot{\overline{\text{H}}}$, and corresponding nearly with Anderson's analysis of the mineral from the Isle of Skye. How calls attention to the close relation of this mineral to apophyllite, and suggests that the existence of carbonate of lime in the cavities with the gyrolite, would seem to show that the latter is formed from apophyllite by the waters which deposited the carbonate of lime, reacting on the silicate of potash, and dissolving out at the same time the fluorid of calcium (this Journal, [2], xxxii, 13).

HALLOYSITE [p. 251, VII].—F. Pisani has analyzed Shepard's *glossecollite*, and proved it to be identical with *halloysite* (*Comptes Rendus*, lii, 310). The specimen examined was received from Des Cloizeaux, who gives the following characters for the mineral. It is compact, with conchoidal fracture; dull, but becomes lustrous on rubbing; color, white; soft and very friable; adheres strongly to the tongue. In water does not soften, but becomes translucent and opaline on the edges, disengaging a few bubbles of air and an argillaceous odor. Heated in the closed tube gives off water, and becomes bluish-gray. B.B. infusible, with cobalt solution gives a blue color. Decomposed by sulphuric acid. Composition:

$\dddot{\mathrm{Si}}$	$\dddot{\overline{\mathrm{Al}}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{H}}$		
40·4	37·8	0·5	21·8	=	100·5

Shepard described it as pure hydrated silicic acid ($\mathrm{Si\,O_3, HO}$).

Harrisite.—See Copper-glance.

Hauyne [p. 230, IX].—Analysis of *hauyne,* from the lava of Melfi, by Rammelsberg:

	$\dddot{\mathrm{S}}$	$\dddot{\mathrm{Si}}$	$\dddot{\overline{\mathrm{Al}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	Cl	
G.=24·66	11·08	34·88	29 34	5·54	0·70	14·47	3·76	*tr.*	= 99·77

(*Zeitschr. geolog. Gesellsch.*, xii, 273, in Kopp's *Jahresbericht,* 1860, 776).

Hornblende [p. 170, I–IV, VI–VIII].—Breithaupt has given the name *gamsigradite* to a black hornblende from Gamsigrad, in Servia. It has a vitreous lustre, velvet-black color, a greenish-gray streak, and is opaque. Cleavage, prismatic. H.=6. G.=3·12. Analysis by R. Müller (*B. and H. Zeitung,* xx, 53):

$\dddot{\mathrm{Si}}$	$\dddot{\overline{\mathrm{Al}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	
46·58	13·63	12·29	6·00	8·83	8·44	3·17	1·00	= 99·94

[The large amount of manganese is quite remarkable; the oxygen ratio, as given by the author, for the bases and silica, is as 16·98 : 24·04 or 2 : 3. It is noteworthy that Rammelsberg, in his extended researches on hornblende, almost invariably found that a portion of the iron in the ferruginous-aluminous varieties was in the state of sesquioxyd.—G. J. B.]

Ilmenite [p. 115, V, VII].—Analysis of titanic iron, from Maxhofen, Bavaria, by J. Müller:

$\ddot{\mathrm{Ti}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\dddot{\overline{\mathrm{Al}}}$	$\dddot{\mathrm{Si}}$	$\dot{\mathrm{Ca}}$	
51·60	41·79[a]	4·00	1·57	0·90	0·30	= 100·166

[a] With *tr.* $\dddot{\overline{\mathrm{Fe}}}$.

Occurs in irregular brittle nodules, of an iron-black color, black streak and sub-metallic lustre. H.=5. G.=4·692 (Kopp, *Jahresbericht,* 1859, 775).

Iolite [p. 214, VII].—N. V. Kokscharow has found *iolite* at Mursinska, in the Ural, where it occurs in masses of the size of a walnut, associated with albite and andalusite. Color, reddish brown; translucent; lustre, vitreous to waxy. H.=7 5. G.=2·605. Chemical examination by Hermann: Heated in the closed tube gives water, and changes color from brown to light blue. B.B. fuses with difficulty to a white enamel. Composition:

$\dddot{\mathrm{Si}}$	$\dddot{\overline{\mathrm{Al}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Li}}$	$\dot{\mathrm{H}}$	
50·65	30·26	4·10	0·60	11·09	0·64	2·66	= 100·00

—*Mat. Min. Russlands,* iii, 253, *in Kopp's Jahresbericht,* 1860, 767.

Irite [p. 103].—Claus considers that this mineral, described by Hermann as a compound of oxydized platinum metals with the oxyds of iron and chromium, is nothing more than a mechanical mixture of several substances. Aside from the improbability of obtaining a pure mineral by the washing of such a complicated mixture as the platinum-residue, Claus made a microscopical examination of the substance obtained by Hermann's method of separation, and found it to be a mixture of several substances, but consisting chiefly of iridosmine and chromic iron.—(*Jour. prakt. Chem.*, lxxx, 285.)

Iron [p. 17, II, VIII].—Boussingault has found traces of nitrogen in the meteoric iron of Lénarto (*Ann. de Chim. et de Phys.*, (3,) lxiii, 336.)

Kämmererite [p. 291].—N. B. DeMarny has found *kämmererite* with chrome-iron in the district of Ufaleisk, in the Ural (*Bull. Soc. Nat., Moscou*, 1860, p. 200). The mineral occurs in imbedded crystals, which in their physical character, very much resemble the clinochlore from Achmatowsk. The crystals have a basic cleavage, and the prismatic faces are horizontally striated. The large crystals are sometimes an inch in diameter, and have a black color and vitreous lustre; the basic planes have a pearly lustre and violet color. The small crystals are transparent, and are of a carmine-red color. Sp. Gr. 2·731.

Kerolite [p. 280].—Analysis of a bluish-white *kerolite*, from Harford County, Maryland, by F. A. Genth (this Journal, [2], xxxiii, 203):

	$\ddot{\mathrm{S}}\mathrm{i}$	$\dot{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{H}}$		
1.	51·20	0·22	26·81	undet.		
2.	51·09	0·23	28·28	20·91	=	100·51
3.	51·02	0·26	27·91	undet.		

KIESERITE.—*Reichardt, Das Salzbergwerk Stassfurth bei Magdeburg*, 1860, in Kopp's *Jahresbericht*, 1860, p. 788.—This name has been given by Reichardt to a salt from Stassfurth, in which he found $\dot{\mathrm{M}}\mathrm{g}$ 21·66, $\dddot{\mathrm{S}}$ 43·05, $\dot{\mathrm{H}}$ 34·56=99·27; this gives the formula $\dot{\mathrm{M}}\mathrm{g}\ \bar{\mathrm{S}}+3\dot{\mathrm{H}}$. Subsequent analyses made by M. Siewert and B. Leopold differed from Reichardt's results, in containing two equivalents less of water.

The substance examined by Siewert consisted of two parts; one portion was opalescent, translucent and friable, while the other was of a darker yellow color, opaque and much harder than the first named. The first was not materially altered when heated at 100° C.; it dissolved in nitric acid, leaving a residue of 0·26 to 0·66 pr. ct., and contained a trace of chlorine; excluding these last as impurities, the composition is represented by analyses 1 and 2. The harder portion gave a residue of 1·5 pr. ct.; when treated with hot water, the residue consisted of sulphate and borate of magnesia. Leopold also found from 0·5 to 1·2 pr. ct. insoluble borates mixed with the specimens he examined.

	$\bar{\mathrm{S}}$	$\dot{\mathrm{M}}\mathrm{g}$	H	
1.	58·98	28·51	13·47	Siewert.
2.	58·90	28·61	——	"
3.	57·78	28·78	14·13	Leopold.

These give the formula $\dot{\mathrm{M}}\mathrm{g}\ \bar{\mathrm{S}}+\dot{\mathrm{H}}$.

Könleinite [p. 472, II].—According to Kenngott, the determinations of J. Fritzsche show that the *könleinite* from Redwitz has the same composition as his so-called hydro-carbon *retén*, $C_{36}\ H_{18}$, and that this species also occurs at Uznach. At the latter locality, könleinite is associated with *scheererite*; at Redwitz it is accompanied by *fichtelite*. It was questioned whether scheererite and fichtelite were identical, but this was not determined. The so-called *phylloretin* was also proved to be identical with *könleinite*.—(*Bull. Acad. St. Petersbourg*, iii, 88, Kenngott, *Uebersicht*, 1860, 116.)

Labradorite [p. 237, VII–IX].—For analyses of *labradorite*, from the black porphyry of Elbingerode and Rübeland, made in the Laboratory at Clausthal under the direction of A. Streng, see *B. and H. Zeitung*, xx, 265.

LANTHANOCERITE (*Hermann, J. pr. Chem.*, lxxxii, 406).—In a paper on cerite, Hermann asserts that two minerals have been known by this name. One, the true *cerite*, loses by ignition from 5 to 6 pr. ct., contains only a very little carbonic acid, and but 7 to 8 pr. ct. of the oxyds of lanthanum and didymium, while it contains from 56 to 64 pr. ct. of oxyd of cerium. The other mineral, which Hermann names *lanthanocerite*, loses 10 to 12 pr. ct. on ignition, contains 4 to 5 pr. ct. of carbonic acid and 34 pr. ct. of oxyds of lanthanum and didymium, and only 26 pr. ct. of oxyd of cerium. Hermann gives no physical characters to distinguish this new species, and quotes his former analyses (see Min., p. 812, Anal. 2, under Cerite,) with merely the additional determination of the relative amounts of the oxyds of lanthanum and didymium present, as follows:

$\ddot{\mathrm{S}}\mathrm{i}$	$\bar{\mathrm{A}}\mathrm{l}$	$\dot{\mathrm{C}}\mathrm{e}$	$\dot{\mathrm{L}}\mathrm{a}$	$\dot{\mathrm{D}}\mathrm{i}$	$\dot{\mathrm{M}}\mathrm{n}$	$\dot{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\mathrm{M}}\mathrm{g}$	$\ddot{\mathrm{C}}$	$\dot{\mathrm{H}}$
16·06	1·68	26·55	16·33	18·05	0·27	3·17	3·56	1·25	4·62	8·10

with traces of cobalt and copper.

Hermann writes the formula: $4(\dot{R}^2\ddot{S}i+\dot{H})+(2\dot{R}_2\ddot{C}+3\dot{H})$.

It seems most probable that the mineral may be an altered substance, or, perhaps a mixture of cerite and lanthanite.

LAPIS-LAZULI [p. 229, VI, VII, IX].—Analysis of *lapis-lazuli*, from Ditro, in Siebenbürgen, by C. v. Hauer (Kenngott, *Uebersicht*, 1860, 54):

	$\ddot{S}i$	$\ddot{\ddot{A}}l$	$\ddot{\ddot{F}}e$	$\dot{C}a$	$\dot{N}a$	$\ddot{S}$
G. = 2·31	40·54	43·00	0·86	1·14	12·54[a]	1·92[b]

[a] By the difference. [b] Loss on ignition.

Found in a hornblendic vein in syenite, associated with pyrites and sphene.

LAZULITE [p. 404, II, VII].—E. J. Chapman has published an article on the *lazulite* from Graves' Mountain, Georgia, in which he endeavors to show that the form is trimetric instead of monoclinic (Canadian Journal, July and September, 1861). In his first article on the subject, Prof. Chapman erroneously considered the crystals as coming from Sinclair county in North Carolina, and he overlooked the fact that the crystals had already been figured by Prof. Dana in Prof. Shepard's article on lazulite in this Journal [2], xxvii, 36. The habit of the crystals and the modifications are monoclinic, and this evidence appears to outweigh that from measurements of crystals having so little lustre. It seems to be a case like datholite, which for a long time was thought to be trimetric, but is now known to be monoclinic.

LAUMONTITE [p. 307, IV–VI].—Analyses of altered *laumontite* from Lake Superior, by Lewinstein show that the crystals are partially converted into feldspar (orthoclase ?)—Kopp, *Jahresbericht*, 1860, 771.

LEPIDOLITE [p. 226, 508].—In conncction with the discovery of the two new alkaline metals *cæsium* and *rubidium* by Bunsen and Kirchhoff, a new analysis of the Rozena *lepidolite* has been made in Bunsen's Laboratory by Cooper. To determine the rubidium with accuracy 13·509 grammes of lepidolite were used.

$\ddot{S}i$	$\ddot{\ddot{A}}l$	$\ddot{\ddot{F}}e$	$\dot{C}a$	$\dot{M}g$	$\dot{R}b$	$\dot{C}s$	$\dot{L}i$	LiFl	NaFl	KFl	$\dot{H}$
50·32	28·54	0·73	1·01	0·51	0·24	*tr*	0·70	0·99	1·77	12·06	3·12=99·99

The total amount of fluorine replacing oxygen is 5·48 per cent.—(*Jour. Prakt. Chem.*, lxxxv, 125.)

Messrs. O. D. Allen and J. M. Blake, of the Sheffield Laboratory, have examined the lepidolite from Hebron and Paris in Maine, and found it to contain very considerable quantities of cæsium and rubidium.

LEUCITE [p. 231, III, V, VI, IX].—Analysis of *leucite* from Vesuvian lava of 1858 by Rammelsberg:

$\ddot{S}i$	$\ddot{\ddot{A}}l$	$\dot{K}$	$\dot{N}a$	$\dot{C}a$	
57·24	22·96	18·61	0·93	0·91	= 100·65

—*Zeitschr. Geolog. Gesellsch.* xi, 496, *in Kopp's Jahresbericht*, 1860, 760.

LIEVRITE [p. 262, IV].—For an article by E. J. Chapman on the position of this species in the mineral series, see Canadian Journal for January, 1862.

LINARITE [p. 390.]—This rare mineral has been found by von Kobell among the lead ores from Vadainsk's Mine in the Nertschinsk District, Siberia, (*J. Pr. Chem.*, lxxxiii, 454). The mineral occurs in radiated clusters of small crystals of an azure-blue color. Measured with the microscope the cleavage angle was 103°. B.B., decrepitates, when slowly heated fuses in the flame of a candle. Analysis gave:

$\dot{P}b\ddot{S}$	$\dot{C}u$	$\dot{H}$ with tr. Cl	
76·41	17·43	6·16	= 100·00

Von Kobell remarks that the slight excess of sulphate of lead and water, was due to an admixture of earthy anglesite.

LOEWIGITE [*A. Mitscherlich J. pr. Chem.*, lxxxiii, 474].—This name has been given by Mitscherlich to the variety of *alunite*, analyzed by Löwig (Sup. V). It is found with *alunite*, at Tolfa in Hungary, as well as at Tabrze in Siberia. It contains the same constituents as *alunite* with the exception of nine instead of six equivalents of water. This water is expelled at a lower heat than in the case of alunite, and the resultant compound instead of containing a mixture of soluble alum and insoluble alumina, consisted of a mixture of sulphate of potash with subsulphate of alumina. It is partially soluble in chlorhydric acid, while alunite is perfectly insoluble. Analyses:

	$\dot{K}$	$\dot{N}a$	$\ddot{\bar{A}}l$	$\ddot{\bar{F}}e$	$\dddot{S}$	$\dot{H}$	$\dot{M}g$	$\dot{B}a$	$\dot{C}a$	$\dddot{S}i$	X(a)	Z(b)
Tabrze,	9·30	0·39	34·95	0·68	34·81	17·88	0·55	0·44	0·28	0·26	0·47	—
Tolfa,	7·17	—	26·29	—	27·63	12·04	3·21	—	0·07	—	—	23·59

a Organic substances. *b* Silicates.

Excluding the silicates in the Tolfa mineral, calculation gives $\dot{K}$ 9·63, $\ddot{\bar{A}}l$ 36·01, $\dddot{S}$ 37·86, $\dot{H}$ 16·50. The formula $\dot{K}\dddot{S}+3\ddot{\bar{A}}l\dddot{S}+9\dot{H}=\dot{K}$ 10·66, $\ddot{\bar{A}}l$ 34·84, $\dddot{S}$ 36·18, $\dot{H}$ 18·32.

Margarite [p. 300, IV].—An analysis of so-called margarite from Pfitschthale near Sterzing, made by Oellacher is given in Kenngott's Uebersicht for 1860, p. 49. It differs entirely in composition from the true *margarite* as analyzed by Hermann, Smith and Brush. Composition:

	$\dddot{S}i$	$\ddot{\bar{A}}l$	$\ddot{\bar{F}}e$	$\dot{C}a$	$\dot{B}a$	$\dot{S}r$	$\dot{M}g$	$\dot{F}e$	$\dot{M}n$	$\dot{K}$	$\dot{N}a$	$\dot{C}u$	$\dot{H}$
G.=2·894	42·59	30·18	0·91	1·03	4·65	0·09	4·85	1·74	0·12	7·61	1·42	0·31	4·43

[A special examination for alkaline earths in the Sterzing margarite made under my direction by Mr. O. D. Allen, proves that it contains no baryta, and only a faint, unweighable trace of strontia. A solution of the alkaline earths from a gramme of the mineral gave, after long standing, a slight turbidity with sulphate of lime. The spectroscope showed the presence of strontia and lime, but not any trace of baryta. —G. J. B.]

Margarodite [p. 223, VIII].—A variety of mica from Derby, Vt., has been named *adamsite* by Prof. C. U. Shepard, on account of some supposed peculiar physical properties (*Hitchcock's Geology of Vermont*, vol. i, p. 484). It is found in thickly disseminated crystals in mica-slate, and Shepard remarks that "its crystalline form is that of mica and but for its perfect inelasticity and greater hardness, it might coalesce with this species." [We do not understand exactly what is meant by "*this species*," as every one knows that there are several species of mica. The specimens of mineral from Derby, Vermont, received from Prof. Shepard, and examined by the writer, have the same hardness, lustre, elasticity, cleavage, specific-gravity, blowpipe characters and chemical composition as margarodite. Analysis gave,

$\dddot{S}i$	$\ddot{\bar{A}}l\ \ddot{\bar{F}}e$	$\dot{C}a$	$\dot{M}g$	Alkalies.	Ign.	
47·76	36·29	0·24	1·85	8·77*a*	5·09	= 100·00

a By difference.

This corresponds very closely with the analyses of margarodite from Monroe, Ct., by Smith and Brush. This identity, and the exact correspondence of its physical properties with margarodite from different localities, leave no doubt as to the propriety of classing the so-called adamsite with this kind of mica.—G. J. B.]

J. Apjohn describes (*Dub. Quar. Jour. Sci.*, i, 119) a new locality of *margarodite* at Ross-Hill, near Maum, Ireland. It has a curved, foliated structure, the laminae not being parallel in masses of any size, but intersecting at various angles. Color white, with tinge of yellowish-green: lustre pearly, sub-translucent. Hardness over 2. G.=2·802. Difficultly fusible. Composition:

$\dddot{S}i$	$\ddot{\bar{A}}l$	$\ddot{\bar{F}}e$	$\dot{C}a$	$\dot{M}g$	$\dot{K}$	$\dot{N}a$	$\dot{H}$	
46·42	37·92	0·46	0·67	0·17	9·63	1·54	4·40	= 101·21

Martite [p. 102, VII].—Dewalque has described an octahedral sesquioxyd of iron from Frassem near Arlon in Luxemburg. Occurs in regular octahedrons in sandstone. Color black; lustre generally dull; fracture earthy, showing no cleavage; streak brick red; sp. gr. 4·35; hardness 7·5. Composition $\ddot{\bar{F}}e$, with 0·33 $\dddot{S}i$, 0·37 $\ddot{\bar{A}}l$, and traces of $\dot{C}a$ and $\dot{M}g$ with 0·2 S. The sulphur indicates it to be a product of the decomposition of pyrites.—(Kopp, *Jahresbericht*, 1860, 775.)

Mica.—For analyses of Black Mica from Canton (Ireland) granite by S. Haughton, see Quar. Jour. Geol. Soc. Dublin, viii, 160.

Millerite [p. 49, I].—F. A. Genth has given analyses of the *millerite* from Gap Mine, Lancaster county, Pennsylvania. (This Journal [2], xxxiii, 195.) It there occurs in coatings of a radiated structure of $\frac{1}{16}$ to $\frac{1}{4}$ of an inch in thickness or concentrically radiated semi-globular masses or tufts. It is frequently tarnished, and many pieces show a commencing alteration into copper-glance, they are dull, of a black color at the upper part of the tufts or little crystals, while the lower part has the brass yellow color and metallic lustre of millerite. Two analyses—No. 1, finest millerite—No. 2, partly altered millerite.

	S	Cu	Ni	Co	Fe	Insol.
1.	35·14	0·87	63·08	0·58	0·40	0·28=100·35
2.	33·60	4·63	59·96		1·32	0·54=100·05

Monazite [p. 402, V].—F. A. Genth mentions a crystal of this species from the gold washings of Todd's branch, Mecklenburgh county, N. C., associated with diamond, garnet and zircon. It is $\frac{1}{4}$ of an inch long, a little over $\frac{1}{8}$ wide and somewhat less than $\frac{1}{8}$ thick, of a yellowish brown color and shows distinctly the following planes: 1, 1*i*, *ii*, *I*, −1 and *ii*. The crystal being slightly waterworn has the edges somewhat rounded, by which some other planes may have been obliterated. G. at 12° C.=5·203. (This Journal [2], xxxiii, 204.)

Nagyagite [p. 65, VIII].—An analysis of *nagyagite* disseminated through a rock from Nagyag gave S. J. Kappel after excluding foreign matter,

S	Au	Fe	Se	Ag	Pb
8·56	12·75	15·11	1·66	1·82	60·10

Kopp, *Jahresbericht*, 1859, 770.

Opal [p. 151, III, IV, VI].—A variety of *hydrophane* from the meerschaum mines near Thebes (Greece) analyzed by G. Tschermak gave,

	$\ddot{\bar{\text{S}}}$i	$\dot{\text{M}}$g	$\dot{\text{H}}$
G.= 2·11 (at 0° C.)	85·8	4·9	9·4=100·1

Wien. Akad. Ber. xliii, 381.

Orthoclase [p. 242, II, III, V–VIII]. — G. vom Rath gives in *Pogg. Ann.* cxiii, 425, measurements of crystals of *adularia* from Ruäras.

Analyses of feldspar from the granite of Canton, Ireland, by S. Haughton (Jour. Geol. Soc. Dublin, viii, 159).

$\ddot{\bar{\text{S}}}$i	$\ddot{\bar{\text{A}}}$l	$\ddot{\bar{\text{F}}}$e	$\dot{\text{C}}$a	$\dot{\text{M}}$g	$\dot{\text{K}}$	$\dot{\text{N}}$a	Ign.
64·48	19·12	0·56	0·45	*tr.*	12·52	3·24	0·16=100·53

Pholerite [p. 251, VIII, IX].—Analysis of *pholerite* from Lodève, Dept. Herault (France), by F. Pisani (*Comptes Rendus*, liii, 1072),

$\ddot{\bar{\text{S}}}$i	$\ddot{\bar{\text{A}}}$l	$\dot{\text{H}}$
47·0	39·4	14·4=100·8

giving the formula $\ddot{\bar{\text{A}}}$l^3$\ddot{\bar{\text{S}}}$i^4+6$\dot{\text{H}}$

Pinite [p. 45].—A. Streng has communicated an analysis of a mineral which he supposes to be identical with Knop's pinitoid (anal. 1). It occurs at Auerberg. No physical characters are given except the specific gravity, 2·75. Streng also gives an analysis of *pinite* (anal. 2) from Mühlenthal, near Elbingerode, where it is found in greenish-gray twelve sided lustreless prisms of a hardness of 2–3. The crystals are often covered with a thin brownish crust. G.= 2·62.—(*B. & H. Zeitung*, xx, 266).

A substance of similar composition from the porphyritic granite of Sasbachwald by Sandberger (anal. 3), by whom it was considered a product of the decomposition of oligoclase (Kenngott, *Uebersicht*, 1860, 39).

	$\ddot{\bar{\text{S}}}$i	$\ddot{\bar{\text{A}}}$l	$\dot{\text{F}}$e	$\dot{\text{C}}$a	$\dot{\text{M}}$g	$\dot{\text{K}}$	$\dot{\text{N}}$a	Ign		
1.	50·95	30·62	2·48	0·35	0·35	9·74	0·12	5·25	=	99·86
2.	47·51	31·17	1·85	1·24	1·55	7·23	0·15	9·02	=	99·72
3.	50·43	28·89		——	3·45	5·12	3·68	5·84	=	97·44

For Nessler's analysis of *oosite*, a pinite-like substance from Oosthal near Baden, see Kenngott's *Uebersicht*, 1860, 42.

Platinum [p. 12, II, III, VI, VIII].—B. Cotta has observed *platinum*, associated with chrome-iron, in what appeared to be a yellowish-serpentine, from the gold district of Nischne-Tagilsk (Kopp, *Jahresbericht*, 1860, 743).

Polybasite [p. 85].—Analysis of polybasite, from Przibram, in Bohemia, by Tonner:

	Ag	Cu	Fe	Sb	S	
G.=6·03	68·55	3·36	0·14	11·53	15·55	= 99·13

Lotos, 1859, 85, in *Jahrb. Min.*, 1860, 716.

Prehnite [p. 314].—Nöggerath describes the occurrence of prehnite, associated with fluor-spar, from Fassathal, in Tyrol (*Sitzungsberichte der niederrheinischen Gesell., Bonn*, vii, 8).

Proustite [p. 78, IX].—Dr. Genth has discovered microscopic crystals of *proustite*, associated with native silver, at the McMakin Mine, Cabarras Co., North Carolina, [this Journal, [2], xxxiii, 195).

Psilomelane [p. 135].—Analysis of *psilomelane*, from Loeh Mine, near Olpe, by K. List:

	$\dot{\text{Mn}}\ \ddot{\overline{\text{Mn}}}$	O	$\dot{\text{Cu}}$	$\dot{\text{Co}}$	$\dot{\text{Ca}}$	$\dot{\text{K}}$	$\dot{\text{H}}$	Insol.
G.=4·699	85·17	4·49	1·28	0·31	0·37	1·36	4·02	2·51

List gives the formula, $\dot{\text{Mn}}^2$, $\ddot{\overline{\text{Mn}}}{}^2+\dot{\text{H}}$. The mineral examined was remarkably pure.—(*Jour. prakt. Chem.*, lxxxiv, 60).

Pyrope [p. 194].—F. A. Genth has analyzed the *pyrope* from near Sante Fé, New Mexico. It has a deep blood-red, sometimes brownish-red color, and forms small somewhat angular grains, from $\frac{1}{8}$ to $\frac{1}{4}$ inches in diameter. G.=3·738. Composition:

$\dddot{\text{Si}}$	$\ddot{\overline{\text{Al}}}$	$\ddot{\overline{\text{Cr}}}$	$\dot{\text{Fe}}$	$\dot{\text{Mn}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	Ign.	
42·11	19·35	2·62	14·87	0·36	5·23	14·01	0·45	= 99·00

Considering the chrome as sesquioxyd, and the iron as protoxyd, the oxygen ratio for $\dddot{\text{Si}}$, $\ddot{\overline{\text{R}}}$, $\dot{\text{R}}$, is as 20·86 : 9·85 : 9·47, or very nearly 2 : 1 : 1=$\dot{\text{R}}^3\,\dddot{\text{Si}}+\ddot{\overline{\text{R}}}\,\dddot{\text{Si}}$, the formula of garnet—(this Journal, [2], xxxiii, 196).

Pyrosmalite [p. 310.—This rare species has been reëxamined by J. Lang (*Jour. prakt. Chem.*, lxxxiii, 424]. It is only found at the mines near Philipstedt, in Wermland, and occurs there in hexagonal prisms, of sometimes an inch in length, imbedded in calcite. Color, blackish-green to liver-brown. H.=4 5. G =3·168–3·174. Decomposed by both nitric and chlorhydric acid. The mean of all the determinations, including two complete analyses, gave:

$\dddot{\text{Si}}$	$\dot{\text{Fe}}$	$\dot{\text{Mn}}$	$\ddot{\overline{\text{Al}}}$	$\dot{\text{Ca}}$	Cl	H
35·43	30·72	20·51	0·24	0·74	3·79	7·75

A special determination showed that only 0·79 of the iron was sesquioxyd; this small amount was thought to be due to a slight alteration of the mineral, or, perhaps, from an error in titration. Lang considers, therefore, that the mineral consists of protochlorid of iron, and a silicate of protoxyd of iron. The formula may be written 3Fe Cl+4 ($\dot{\text{R}}^3\,\dddot{\text{Si}}+2\dot{\text{R}}^3\dddot{\text{Si}}{}^2+6\dot{\text{H}}$).

Pyroxene [p. 158, I, II, V–IX].—Analysis of *pyroxene*, from the Vesuvian lava of 1858, gave Rammelsberg $\dddot{\text{Si}}$ 49 61, $\ddot{\overline{\text{Al}}}$ 4·42, $\dot{\text{Fe}}$ 9·08, $\dot{\text{Ca}}$ 22 83, $\dot{\text{Mg}}$ 14·22, $\ddot{\overline{\text{Fe}}}$ undet.=100·16.—Kopp, *Jahresbericht*, 1860, 758.

Des Cloizeaux has shown, by optical examination, that *enstatite*, *bronzite*, *hypersthene* and *wollastonite* are distinct from *pyroxene* in their crystalline form and optical properties (*Comptes Rendus*, lii, 786). For analysis of a pyroxene pseudomorph, by Pisani, see *Comptes Rendus*, liv, 51.

Pyrophyllite [p. 303, I, V, VI, VII].—In an examination of different varieties of Chinese figure-stone (pagodite) made in 1858, I found a compact variety of pyrophyllite, which seemed to bear the same relation to ordinary pyrophyllite as steatite does to talc. In chemical composition it was identical with the radiated mineral, but it differed in hardness and pyrognostic characters. Since the publication of this result, I have examined a large number of so-called steatites, and have found among them many specimens of this compact pyrophyllite. Among these specimens is a so called soapstone, from Deep River, Moore Co., North Carolina. It has a schistose, or imperfectly lamellar structure, resembling talcose-slate. Laminæ, not sufficiently distinct to be separable; brittle. Color, greenish to yellowish-white. Cleavage very distinct, resembling talcose slate. H.=1·5. Sp. gr. 2·92. Before the blowpipe, in the closed tube, yields water; in the platinum forceps exfoliates slightly, and by prolonged heating, fuses with difficulty on the thin edges. With cobalt solution gives a reaction for alumina.

I received a second specimen, of a similar character, from Dr. F. A. Genth, who has kindly furnished me with several interesting steatitic minerals for examination. Dr. Genth informs me that it was found at Carbonton, Moore Co., North Carolina. It is more distinctly laminated than the specimen from Deep River, and was somewhat whiter in color, and had a density of 2·82.

These minerals have been analyzed, under my direction, in the Sheffield Laboratory of Yale College. No. 1, by Mr. Samuel T. Tyson; No. 2, by Mr. Oscar D. Allen:

	$\dddot{Si}$	$\bar{\bar{A}}l$	$\bar{\bar{F}}e$	$\dot{H}$	
1. Deep River,	65·93	29·54		5·40	Tyson.
2. Carbonton,	66·25	27·91	1·08	5·25	Allen.

The composition is the same as that of the radiated and compact pyrophyllite, and this new and interesting variety is intermediate between the two extremes of structure. It furnishes additional evidence that the peculiar pyrognostic characters of the lamellar-radiated variety are due entirely to the structure of the mineral. My attention was first called to this substance by Mr. George Munger, of the firm of Dean & Munger, of this city, who have brought it into use extensively in the form of pencils for writing on slates and blackboards, for which purpose it is exceedingly well adapted.

Quartz [p. 145, II, III, IV, VII, VIII].—Rammelsberg has published an interesting series of experiments on the action of caustic potash on different varieties of silicic acid (*Pogg. Ann.*, cxii, 177). He confirms the observation of Fuchs and Rose, that caustic potash very perceptibly attacks quartz, and shows the impossibility of determining the relative amount of amorphous silica in hornstone, agate, chrysoprase, etc., by this means. These minerals consist chiefly of quartz, as H. Rose has already determined; their density, which is generally near 2·6, favors this conclusion. They always contain water, and their density is thereby lessened. Some varieties of chalcedony are dissolved to a great extent in caustic potash, but their specific gravity proves that the quantity of amorphous acid which they contain is much less than that indicated by the amount taken up by the potash solution. A specimen of chalcedony, from Hungary, with a density of 2·567, left, on repeated treatment with potash, a residue which amounted to only 6·12 per cent of the original substance. Opals also were found to differ very much in their solubility; many varieties appeared to contain quartz.

To ascertain the relative amount of quartz and amorphous silicic acid in these substances, Rammelsberg proposes to follow out the suggestion of Fuchs, who showed that when either powdered opal, or artificially prepared silicic acid, were mingled with caustic lime and water, they harden after some months into a sort of cement, which contains a silicate that gelatinizes with acids. Quartz is entirely without action on the lime when thus treated. Rammelsberg also remarks, that the optical properties of these minerals, although of great interest, do not offer a solution of the chemical side of the question.

G. Rose has observed crystallized quartz in the metallic iron of Xiquipilco, in Mexico. The crystal examined was $\frac{1}{3}$ of a line in diameter (*Pogg. Ann.*, cxiii, 184).

Rastolyte.—See Chlorite.

Rhodonite [p. 167, III].—Analysis of rhodonite, from Shäbenholz, near Elbingerode, by H. Hahn:

$\dddot{Si}$	$\dot{M}n$	$\dot{C}a$	$\dot{M}g$	$\dot{F}e$	$\bar{\bar{A}}l$	FeS_2	$\dot{H}$
44·86	42·98	3·06	6·15	1·52	0·74	0·40	0·95=100·65

B. und H. Zeitung, xx, 267.

ROESSLERITE [*R. Blum. Jahresber. d. Wetterauer Gesellsch.*, 1861, 32].—This name has been given by Blum to a new hydrous arseniate of magnesia, from the Kupfershiefer of Bieber. It is found in thin crystalline plates, with a columnar to fibrous structure, and sometimes in vermiform efflorescences. Cleavage, distinct in one direction. H.=2–3. Translucent to opaque; lustre, vitreous to dull. The translucent mineral on exposure loses its vitreous lustre, becomes opaque, dull and white. B.B. fuses to a white enamel, and in the closed tube gives water. Soluble in chlorhydric acid. Analysis by Delffs:

	$\dot{M}g$	$\dddot{\bar{A}}s$	$\dot{H}$
	14·22	40·16	45.62
Oxygen,	5·69	13·97	40 55

giving the formula $\dot{M}g^2 \dddot{\bar{A}}s + 15\dot{H} = \dot{M}g$ 13·80, $\dddot{\bar{A}}s$ 39.65, $\dot{H}$ 46·55=100·00.—*Jahrb. Min.*, 1861, 334.

SCHEELITE [p. 347, VIII].—Analysis of a very pure variety from Traversella, by Bernouilli, gave,

$\dddot{W}$	$\dot{C}a$	
80·70	19·25	= 99·95

Taking the equivalent of tungsten at 93·4, the formula $\dot{C}a \dddot{W}$ requires $\dddot{W}$ 80·74, $\dot{C}a$ 19·26.—(*Pogg. Ann.*, cxi, 607, in Kenngott's *Uebersicht*, 1860, 31.)

SERPENTINE [p. 282, I–IX].—Analysis of *serpentine*, resulting from the alteration of chrysolite, from Webster, North Carolina, gave Genth:

$\ddot{S}i$	$\dddot{A}l$	$\dot{F}e$	$\dot{M}g$	$\dot{M}n$	$\dot{N}i$	$\dot{C}a$	Chrome-iron.	Ign.	
43·87	0·31	7·17	38 62	*tr.*	0·27	0·02	0·57	9·55	= 100·88

Dr. Genth remarks, that in the change of chrysolite into talc or serpentine, a portion of the magnesia is eliminated, which separates as brucite, hydromagnesite, magnesite, or dolomite, minerals which occur more or less at the principal serpentine localities. For further observations on *serpentine*, see Dr. Genth's paper in this Journal, [2], xxxiii, 201–203.

G. Servinstein has analyzed a serpentine pseudomorph of phlogopite from Somerville, New York (*Zeitschrift für Chemie und Pharmacie*, 1860, iii, 15).

Sexangulite.—See GALENA.

Spiautrite.—See WURTZITE.

SPINEL [p. 103, II].—F. A. Genth has analyzed the *automolite* from the Canton Mine, Georgia. The crystals are of a deep leek-green color, and a vitreous lustre, and present octahedral, and dodecahedral planes, the latter deeply striated. Composition:

$\ddot{S}i$	$\dot{C}u$	$\dddot{A}l$	$\dddot{F}e$	$\dot{F}e$	$\dot{Z}n$	$\dot{M}n$	$\dot{M}g$	
2·37	1·23	53·37	6 68	3·01	30·27	0·20	3·22	= 100·35

(This Journal, [2], xxxiii, 196.)

Stassfurthite.—See BORACITE.

STAUROTIDE [p. 261, III].—This species has been subjected to a critical reëxamination by Rammelsberg (*Pogg. Ann.*, cxiii, 599). He finds that all the varieties examined contain protoxyd of iron, and that most of the iron is in this state; some varieties contained no sesquioxyd, while others contained from 0·88 to 5·21 pr. ct. $\dddot{F}e$, and from 10·45 to 13·32 $\dot{F}e$. The silica varied from 28 86 to 51·32 pr. ct., and the alumina from 34 30 to 49·19. Specimens from the same locality varied materially in composition. The following varieties were examined:—I. From Massachusetts; occurs in black and brownish-black crystals, rhombic prisms of 129° 44′, with replacement of the acute edges and terminal plane on the obtuse edges, associated with black-mica and albite. The magnet extracted from the powdered mineral a small amount of magnetite. Fragments were translucent-brown, and the powder, yellowish-brown color. Sp. gr.=3·772.—II. St. Gotthardt. This is the well-known variety of brown staurotide, associated with kyanite and a compact variety of mica, which Schafhäutl has called *paragonite*, and which, according to Rammelsberg, is possibly identical with margarodite or damourite. Rammelsberg remarks that the exact locality of this variety, as well as that under VII, is uncertain. The locality, St. Gotthardt, has been misapplied to this, as also to other minerals, some of which come from portions of Switzerland, very distant from St. Gotthardt; but as the exact locality is doubtful, R. still calls it by this name. Sp. gr. 3·744 (Jacobson).—III. St. Gotthardt. This, although associated with kyanite in a similar manner to the last, has a very different composition. The staurotide crystals frequently enclosed thin blades of kyanite, so that great care was required to obtain pure mineral.—IV. Franconia, New Hampshire. Large crystals, enclosing garnets; color, brown on the edges. G.=3·764.—V. Goldenstein, in Moravia. Brown crystals, in a reddish-brown mica-slate, associated with white or red quartz, with single small garnets. The staurotide resembles the St. Gotthardt variety in translucency, but the crystals are often covered externally with mica. Streak, yellowish brown. G.=3·654–3·66.—VI. Litchfield, Connecticut. Black crystals in mica-slate; streak, brownish-gray. G.=3·622.—VII. Airolo. The same variety as analyzed by Jacobson. Black crystals in a gray mica-slate, associated with brown garnets. Color, in thin pieces, yellowish-gray; and although the magnet takes up nothing from the powdered mineral, still it does not appear to be entirely pure. G.=3·66–3·73 (Jacobson).—VIII. Lisbon, New Hampshire. Pretty large yellowish-brown crystals in a gray mica-slate, with garnets of an amethystine tinge (this locality is known among American mineralogists as Mink-Pond.—G. J. B.). G.=3·413. —IX. Brittany. A twin crystal, with rounded edges. G.=3·527–3·529 (Jacobson). —X. Pitkäranta, Finland. Large crystals in gray mica-slate; the planes are usually covered with glistening scales of mica. Streak, yellowish-gray. G.=3·265.

The following are the results of the analyses:

			$\bar{\bar{\text{Si}}}$	$\bar{\text{Al}}$	$\bar{\text{Fe}}$	$\dot{\text{Fe}}$	$\dot{\text{Mn}}$	$\dot{\text{Mg}}$	Ign.	
A.	1.	Massachusetts,	28·86	49·19	3·20	13·32	1·28	2·24	0·43=	98·52
	2.	Gotthardt,	29·60	48·53	4·25	11·50	0·96	3·12	0·76=	98·72
B.	3.	Gotthardt,	35·05	44·18	5·21	11·48	*tr.*	2·86	0·95=	99·73
	4.	Franconia,	35·36	48·67	2·27	13·05	*tr.*	2·19	0·27=	101·80
	5.	Goldenstein,	35·15	44·02	0·88	12·16	1·41	3·06	1·27=	97·95
	6.	Litchfield, Ct.,	36·92	42·92	1·85	12·80	0·70	2·93	1·00=	98·82
C.	7.	Airolo?	43·26	40·45	2·40	10·92	——	2·09	0·45=	99·57
D.	8.	Lisbon, N. H.,	49·10	37·70	——	10·69	*tr.*	1·64	0·68=	99·81
	9.	Brittany,	50·75	34·86	2·86	10·45	*tr.*	1·80	0·38=	101·10
	10.	Pitkäranta,	51·32	34·30	——	11·01	0·42	2·32	0·59=	99·96

The oxygen ratios are as follows:

	$\dot{R} : \bar{R} : \bar{\bar{\text{Si}}}$	or $\dot{R}, \bar{R} : \bar{\bar{\text{Si}}}$		$\dot{R} : \bar{R} : \bar{\bar{\text{Si}}}$	or $\dot{R}, \bar{R} : \bar{\bar{\text{Si}}}$
1.	0·5 : 3 : 1·9	1·84 : 1	6.	0·6 : 3 : 2·8	1·3 : 1
2.	0·5 : 3 : 1·9	1·84 : 1	7.	0·5 : 3 : 3·5	1 : 1
3.	0·5 : 3 : 2·49	1·4 : 1	8.	0·5 : 3 : 4·4	0·8 : 1
4.	0·48 : 3 : 2·37	1·5 : 1	9.	0·5 : 3 : 4·5	0·8 : 1
5.	0·6 : 3 : 2·65	1·36 : 1	10.	0·65 : 3 : 5·0	0·73 : 1

Rammelsberg classifies these under four heads: (A,) including analyses 1, 2; (B,) 3, 4, 5, 6; (C,) 7; (D,) 8, 9, 10; and considers that the results show a relation between the different varieties similar to the isomorphous members of the feldspar group. The general formula may be written, $(\dot{R}, \bar{R}^3) + \bar{\bar{\text{Si}}}^n$.

Dr. Genth has published, in his "Contributions to Mineralogy," a description and three analyses of the so-called staurotide, from Canton Mine, Geo., (this Journal, xxxiii, 198). It occurs in minute crystals, rarely of $\frac{1}{4}$ of an inch in length, of a yellowish-brown or cinnamon-brown color, apparently right rhombic prisms, similar to those of staurotide, with planes I and *i*ĭ. G. at 27° C.=3·792, associated with copper and lead ores. The mean result of three closely agreeing analyses was,

$\bar{\bar{\text{Si}}}$	$\bar{\bar{\text{Ti}}}$	$\bar{\text{Al}}$	$\bar{\text{Fe}}$	$\dot{\text{Zn}}$	$\dot{\text{Mn}}$	$\dot{\text{Mg}}$	$\dot{\text{Cu}}$ $\dot{\text{Ag}}$	Ign.	
28·82	0·84	49·21	9·51	7·13	0·15	3·22	*tr.*	1·47	= 100·35

This, when compared with the above mentioned results of Rammelsberg, show this mineral to be an exceedingly interesting variety of staurotide, in which a portion of the protoxyd of iron is replaced by zinc.

SZAIBELYITE (*K. F. Peters, Ber. Wien. Akad.*, xliv, 143).—Peters has discovered an exceedingly interesting borate in a gray granular limestone from Werksthal near Retzbanya, to which he gives the name *szaibelyite.* The structure of the limestone somewhat resembles a coral, showing on the fractured surface numerous light colored circular spots surrounded by a dark crust. The hardness of the interior of these spheroidal masses was such that it was scarcely scratched by steel, while the crust was nearly as soft as limestone. Treated with dilute acid, the mass of limestone was dissolved away, leaving numberless needle-like crystals, in some cases attached to the kernels in such a manner, that the author compares them to a pin-ball. Viewed under the microscope the crystals appeared to belong to either the monoclinic or triclinic systems. With Nicol's prisms, both the needles, and the kernels were biaxial. In these respects the mineral very much resembles *hayesine.* A chemical examination made by Preyss showed that a solution obtained by acting on the needles with strong chlorhydric acid, gave evidence of the presence of boracic acid and magnesia. A further examination made by Peters proved it to be hydrous borate of magnesia and soda with some chlorine, but containing neither lime or alumina. He calls attention to the remarkable analogy between it and hayesine, but suggests also that it may be classed nearer Volger's *parasite* or Rose's *stassfurthite.* If the soda is an unimportant constituent, it may possibly be identical with the latter mineral.

Talc [p. 275, V, IX].—A talc from Webster, Jackson Co., N. C., which Dr. Genth considers the result of the alteration of chrysolite, gave on analysis (this Journal, [2,] xxxiii, 200):

$\dddot{Si}$	$\bar{\dddot{Al}}$	$\dot{Fe}$	$\dot{Ni}$	$\dot{Mg}$	$\dot{H}$	
64·44	0·48	1·39	0·23	33·19	0·34	= 100·07

The absence of water is remarkable.

Tetrahedrite [p. 82, I, II, V, IX].—Ch. Mène gives additional analyses of the so-called *fournetite* (Suppl. IX,) in the *Comptes Rendus*, lii, 311, 1326; also a new locality of the mineral in the Val Godemar (Hautes-Alpes). According to Mène, this variety of gray copper resembles iron-pyrites, except that its color is steel-gray, with greenish reflections. It is amorphous and compact. Mean of three analyses of the Val Godemar mineral, after excluding from 4·7 to 10·10 pr. ct. of quartz:

	Cu	Pb	S	Fe	As	Sb	
G.=4·30	30 80	11·50	21·70	4·50	10 00	21·50	= 100·00

giving the formula $3Cu_2S+2Sb_2S_3+PbS+Fe_2As_3$, while that from Ardillats gave $3Cu_2S+3Sb_2S_3+PbS+FeAs$. Both varieties contained silver; that from Ardillats, 0·05 to 0·21 pr. ct., and from Val Godemar, 0·08 to 0·11 pr. ct.

Texalite.—See Brucite.

Topaz [p. 259, IV].—Analyses of *topaz*, by H. St. Claire Deville (*Comptes Rendus*, lii, 782):

	$\dddot{Si}$	$\bar{\dddot{Al}}$	Si	Fl	
1. Saxony,	22·3	54·3	6·5	17·3	= 100·4
2. Brazil,	25·1	53·8	5·8	15·7	= 100·4

Tritomite [p. 319, III].—F. P. Möller has analyzed this mineral in Prof. Bunsen's Laboratory, with following results. G.=4·26: $\dddot{Si}$ 15·38, $\ddot{Sn}$ 0·74, $\ddot{Ta}$ $\ddot{Zr}$ 3·63, $\bar{\dddot{Ce}}$ 4·48 $\bar{\dddot{Mn}}$ 0·49, $\bar{\dddot{Fe}}$ 2·27, $\bar{\dddot{Al}}$ 1·61, $\dot{Ce}$ 10·66, $\dot{La}$ $\dot{Di}$ 44·05, Y 0·42, $\dot{Ca}$ 6·41, $\dot{Ba}$ 0·19, $\dot{Sr}$ 0·71 $\dot{Mg}$ 0·16, $\dot{K}$ 2·10, $\dot{Na}$ 0 56, $\dot{H}$ 5·63=99·49

The 3·63 pr. ct. tantalic and zirconic acid was called so with a query, there having been something anomalous in its reactions. These results differ very materially from the earlier analyses by Berlin and Forbes, but great care seems to have been taken in obtaining accurate results, especially in the determination of the state of oxydation of the bases. Müller gives the formula $3\dot{R}^4\dddot{Si}+\bar{\dddot{R}}\,\dddot{Si}^3+6\dot{H}$.—*Ann. Chem. Pharm.*, cxx, 241.

Uranite [p. 430, IV.]—Des Cloizeaux has already shown, by optical examination, that *uranite* and *chalcolite* belong to different crystalline systems, uranite being trimetric, while chalcolite is dimetric. Pisani has now re-examined the chemical composition of these two minerals, and finds that the uranite of Autun, when air-dried, has 12 atoms of water, the amount remaining constant even after months of exposure, while chalcolite, from Cornwall, has but 8 atoms. When uranite is heated to 70° C. it loses 4 atoms of water, but Pisani considers this as constitutional and not as hygroscopic water. Analyses gave,

	$\dddot{P}$	$\overline{U}r$	$\dot{C}a$	$\dot{C}u$	$\dot{H}$	Sand.	
1. Uranite, Autun,	13·4	56·47	5·60	—	20·00	3·20	= 98·67
2. Chalcolite, Cornwall,	14·0	59·67	—	8·50	15·00	0·40	= 97·57

No. 1, excluding sand and calculating up to 100, gives $\dddot{P}$ 14·0, $\overline{U}r$ 59·0, $\dot{C}a$ 5·8, $\dot{H}$ 21·2; No. 2, calculated in the same manner, equals $\dddot{P}$ 14·4, $\overline{U}r$ 61·5, $\dot{C}u$ 8·6, $\dot{H}$ 15·5, giving the formula for uranite, $(\dot{C}a, \overline{U}r^2)\dddot{P}+12\dot{H}$; for chalcolite, $(\dot{C}a, \overline{U}r^2)\dddot{P}+8\dot{H}$, (*Comptes Rendus*, lii, 817).

Wagite.—See Calamine.

Whitneyite [VII, IX].—Dr. F. A. Genth has published additional analyses of this rare species (this Journal, xxxiii, 191). The specimen examined was furnished by Prof. Booth of the U.S. Mint, and was thought to be from the north shore of Lake Superior. On examination it proved to consist of two minerals, *whitneyite* and *algodonite*. The whitneyite is compact, with a fine grained structure, and a reddish to grayish white color, and no lustre on surfaces of fresh fracture. Scratching developes a strong metallic lustre, and a reddish-white color, but it soon tarnishes. G.=8·246–8·471, the variation probably due to porosity. Hardness a little less than that of fluor. Slightly malleable. Fracture sub-chonchoidal. Analysis:

	As	Cu	Ag	
1.	10·92a	87·64	0·19	= 98·75
2.	12·29	87·48	0·04	= 99·81
3.	12·28	87·37	0·03	= 99·68

a Too low.—F. A. G.

The specimen analyzed was not entirely free from algodonite, but gives very nearly the atomic composition, Cu_{18} As=As 11·64, Cu 88·36.

[While on a visit to Lake Superior, last summer, I learned from Mr. A. B. Wood that a loose mass of whitneyite, weighing about 15 lbs., had been found on the Pewabic location, about one mile from the village of Hancock, Portage Lake. A specimen of *whitneyite* mixed with *algodonite*, similar to that mentioned by Dr. Genth, is in the Yale College Cabinet, and was received some years since from Prof. Booth, who remarks on the label, that he broke it from a mass weighing 50 lbs. It thus seems that these arsenids of copper must occur in considerable abundance, and although thus far, they have not been found in place, we may hope that explorations will soon give us the exact locality.—G. J. B.]

Wolfram [p. 351, I–IV, VIII, IX].—Analyses of *wolfram*, by F. A. Bernouilli (*Pogg. Ann.* cxi, 603, in Kenngott's *Ubersicht*, 1860, 93):

	$\dddot{W}$	$\dot{F}e$	$\dot{M}n$	$\dot{C}a$	$\overline{C}b$	
1. Chanteloupe,	75·68	18·77	5·01	0·22	—	= 99·68
2. "	75·75	18·08	5·75	—	0·31	= 99·89
3. Traversella,	75·99	16·29	3·45	4·03	—	= 99·76
4. Zinnwold,	75·15	9·72	13·99	*tr.*	1·10	= 99·96
5. "	76·20	5·60	17·94	—	—	= 99·74
6. "	75·98	18·51	5·02	—	0·52	=100·03
7. "	76·13	18·49	5·10	—	—	= 99·72

Showing that the bases replace each other in all proportions, and that even from the same locality the composition of different specimens may vary.

Wollastonite [p. 156, II].—Analysis of *wollastonite*, from the granular limestone at Auerbach, by W. Hampe:

$\dddot{S}i$	$\dot{C}a$	$\overline{F}e$	$\overline{A}l$	
52·01	46·74	0·93	1·87	= 101·55

B. and H. Zeitung, xx, 267.

WURTZITE [*C. Friedel, Comptes Rendus*, lii, 983].—This new species is from a silver mine near Oruro, in Bolivia. It is a hexagonal sulphid of zinc, isomorphous with *greenockite*. The following are its characters: Color, brownish-black; lustre, vitreous; streak, brown. Before the blowpipe, and with reagents, gives the same reactions as blende. The crystals are double hexagonal pyramids, in some cases showing the faces of the hexagonal prism, which are striated parallel to the base. The angle between the prismatic and pyramidal planes could not be measured with accuracy, but the mean of several measurements gave about 129°; this is near that of the same angle in greenockite (127° 45′). Cleavage, both basic and prismatic. G.=3·98. H.=3·5—4. Composition:

S	Zn	Fe	Pb	Sb	Cu
32·6	55·6	8·0	2·7	0·2	*tr.* = 99·1

The lead and antimony are due to the gangue, the mineral being associated with sulph-antimonid of lead, and the slight excess of sulphur is owing to the presence of a small amount of pyrites, the presence of which was distinguished by a magnifier. The composition is essentially that of blende, while the hexagonal form proves that natural sulphid of zinc is dimorphous, a fact before established in regard to the artificially produced sulphid. It is named in honor of Adolph Wurtz, the distinguished French chemist.

Breithaupt has published in the *Berg und Hüttenmännische Zeitung*, xxi. 98, the fact that two years since he discovered that the radiated blende from Przibram was hexagonal, and he gave it in his lectures the name *spiautrite*. More recently he has found that the radiated blende from Albergaria Velha in Portugal is also hexagonal. —The name *wurtzite* has the priority in publication, and consequently will be used for the hexagonal form of sulphid of zinc.

YTTRO-TANTALITE [p. 359, IV, IX].—Analysis of amorphous brown *yttro-tantalite* from Kararfvet by Chydenius. $\bar{\text{T}}\text{a}$ 56·44, $\dot{\text{Z}}\text{n}$ 0·42, $\dot{\text{Y}}\text{t}$ 30·43, $\dot{\text{C}}\text{a}$ 2·27, $\dot{\text{C}}\text{u}$ 0·27, $\dot{\text{F}}\text{e}$ 3·27, $\ddot{\text{U}}$ 1·19, $\dot{\text{H}}$ 4·83=99·12 —Kenngott's *Uebersicht*, 1860, 93.

ZINCITE [p. 110, II, III, IX].—The new synonym *Ruby-Zinc* has been proposed for this species by F. Alger.—*Proc. Boston Soc. Nat. Hist.*, viii, 145.

ZIRCON [p. 195, IV].—Kokscharow has found that the so-called *engelhardite* from Ilginsk is identical with zircon.—Kopp's *Jahresbericht*, 1860, 756.

NOTE.—As a new edition of the Mineralogy is now in course of preparation, this is the last Supplement which will be issued before its publication.

Sheffield Laboratory, Yale College, June 16th, 1862.

ART. XX.—*On Phosphatic Guano Islands of the Pacific Ocean;** by J. D. HAGUE.

DURING a few years past the attention of scientific men and of agriculturists has been called to some varieties of Phosphatic Guano found on several small islands of the tropical Pacific and imported to this country and to Europe under the name of "American Guano."

The principal ingredient of these guanos is the phosphate of lime, with which is combined in the various sorts more or less

* Much of the chemical investigation of which the results are given in this paper I made in the Sheffield Laboratory of Yale College, the facilities of which were kindly afforded me by my friends, Profs. Brush and Johnson, to whom I am happy to express my thanks for this favor, and for their valuable assistance in the prosecution of my work. Also to my brother, Mr. Arnold Hague, one of their students, my acknowledgments are due for analytical aid. J. D. H.

phosphate of magnesia, sulphate of lime, organic matter and water. They generally contain traces of ammonia with a small percentage of soluble salts, but these, which, without doubt, formed an important part of the guano as it originally existed, have now almost entirely disappeared in consequence of the various changes to which the deposits have been subjected.

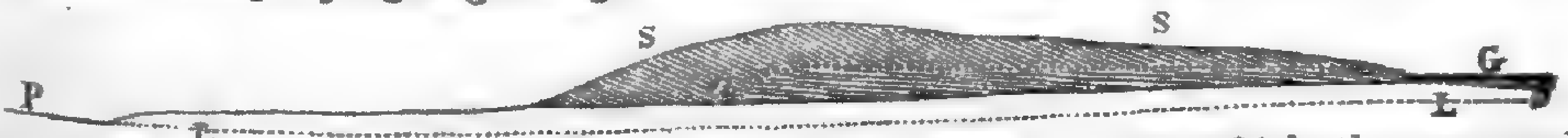
The first samples of these guanos were taken from Jarvis' and Baker's Islands in 1855 and sent to the United States for examination, the results of which led in 1858 to the occupation and working of the deposits. The importance and value of these having once become evident, the Pacific, within a few degrees north and south of the equator, was carefully explored and many other islands were visited, on a few of which beds of guano of some extent were discovered.

In the following paper I propose to describe some of these. I shall have reference chiefly to Baker's, Howland's and Jarvis' Islands, on each of which I resided several months for the purpose of studying the character and formation of their deposits. I also spent some months in exploring this region of the Pacific and visiting many other islands, having a small vessel employed especially for that object. In this service, altogether, I was engaged more than two years, from 1859 to 1861 inclusive, in the employ of William H. Webb, Esq., of New York, by whose courtesy I am permitted to publish these results.

These islands are all of coral formation. They are situated near the equator and between the meridians of about 155° and 180° longitude west from Greenwich. They are without fresh water and almost entirely destitute of vegetation, and are the resort of countless thousands of birds whose accumulated ordure and dead bodies have formed extensive deposits.

Baker's Island.—This island possesses the most important of these deposits. It is situated in lat. 0° 13′ north and long. 176° 22′ west from Greenwich. Excepting Howland's Island, forty miles distant, it is very remote from any other land. It presents the usual features of an ordinary coral island. It is surrounded by a fringing reef, which is from 200 to 400 feet wide and slightly elevated above the sea level at low tide. It is about one mile long and two-thirds of a mile wide, trending east and west. The surface is nearly level, the highest point of which is twenty-two feet above the level of the sea, showing some evidences of elevation.*

* The accompanying engraving exhibits a section of the western (lee) beach which



was cut through for a railway. LL is the level of the reef of which the seaward end P is the shore platform or plateau covered at high tides by five and a half feet

Above the crown of the beach there is a sandy ridge which encircles the guano deposit. This marginal ridge is about one hundred feet wide on the lee side of the island, and is there composed of fine sand and small fragments of corals and shells mixed with considerable guano; on the eastern or windward side it is much wider and formed of coarser fragments of corals and shells which, in their arrangement, present the appearance of successive beach formations. This margin is partially covered with a rank growth of long, coarse grass, portulacca, mesembryanthemum, and a few other species of plants.

Encircled by this ridge lies the guano deposit occupying the centre and the greater part of the island. The surface of this deposit is nearly even, but the hard coral bottom which forms its bed has a gradual slope from the borders towards the centre, or, perhaps more properly, from northwest to southeast, giving the guano a variable depth from six inches at the edges to several feet at the deepest part. None of the grass that grows abundantly on the margin is found on the guano, but there are one or two species of portulacca occurring in certain parts, (particularly where the guano is shallowest and driest), and to this is owing the presence of the fine roots and fibres in some of the guano.

The entire deposit presents considerable uniformity in character. Excepting some isolated spots of little extent there is no outer crust, and the guano of the surface differs but little, if any, from that below. There is, however, some variety in the appearance of the guanos of the deep and shallow parts of the deposit. On the northern side it is from six to twelve inches deep; is generally quite dry, and is a dark brown pulverulent substance of rather coarse grain or texture, containing many thread-like roots and fibres and whitish particles, among which Prof. Liebig

of water. From the shore to the edge of the guano deposit G, is from 300 to 400 feet. The perpendicular height from LL to the summit of the sand beach, SS, is twenty-two feet, and the depth of the excavation opposite this highest point is ten feet, the drawing being a little out of proportion.

The dotted line, *ab*, represents an old beach formation which the cut exposed. It consists of large and small coral fragments and shells beneath which the sand lies in compact strata. This formation was evidently once the surface of the island, and may be traced from *a* to *b*, where the guano rests upon it. Above it lies a sandy ridge, SS, a comparatively new beach accumulation rather indistinctly stratified. The highest point of *ab* is fifteen feet above LL, which altitude, in accordance with the commonly accepted theory that the sea-made coral land does does not exceed ten feet in height, would, of itself, be an evidence of elevation and, consequently, to account for the present height of twenty-two feet, it would be necessary to suppose a subsequent subsidence in order to allow SS to accumulate, and finally another elevation of the whole to its present position. It must be observed, however, that the sandy ridge, SS, only prevails at this altitude on the southwestern shore, and probably violent westerly gales and heavy seas have had much to do with its formation. My own observations favor the opinion that the sea-made coral land may reach a greater altitude than ten or twelve feet. During the prevalence of high surf at Jarvis Island I have known seas to wash up the beach with body and force sufficient to carry away plank and spars that were lying on the crown of the beach eighteen feet above the level of the reef.

observed scattered crystals of the phosphate of magnesia and ammonia.* It is closely though not hard packed, and is readily removed by shovels without the aid of picks. In this part of the deposit the portulacca flourishes most.

The guano on the southern side is of reddish color, of finer texture, much damper, and of less specific gravity than that just described. There is much less vegetation in this part of the deposit, and the guano here contains scarce any roots or fibres.

Chemically these varieties do not differ very much. Usually the darker sort contains less water and more organic (vegetable) matter, from which it probably derives its color.

Analyses of these two sorts are given beyond.

Much light may be thrown on the formation of these deposits by the analysis, (I) which follows, showing the composition of recently deposited guano. The sample itself does not represent any considerable part of the existing deposit, but was taken from a locality where large numbers of birds are still accustomed to congregate. It is the dung of the Pelicanus Aquilus, commonly called the Frigate Bird, which of all the birds frequenting the island is the only one whose recent evacuations are of such a consistency that they may conveniently be collected. They contain a large proportion of solid matter, while the evacuations of nearly all the other birds are very thin and watery. It is found in their favorite roosting places, and shows the character of guano before it has long been subjected to the influence of the weather. It is a light and dry substance, consisting of friable grains or fine powder, of a brown color, smelling strongly of ammonia. Of the three following analyses No. I is this freshly deposited guano; No. II is of the light colored guano from the deeper part of the deposit, and No. III of the dark guano from the shallow part.

	I.	II.	III.
Moisture expelled at 212° Fahr.,	10·40	2·92	1·82
Loss by ignition,	36·88	8·32	8·50
Insol. in HCl, (unconsumed by ignition),	·78	...	...
Lime,	22·41	42·74	42·34
Magnesia,	1·46	2·54	2·75
Sulphuric acid,	2·36	1·30	1·24
Phosphoric acid,	21·27	39·70	40·14
Carbonic acid, chlorine and alkalies, undet.,	4·44	2·48	3·21
	100·00	100·00	100·00
Sol. in water remaining after ignition,	3·63		

No. I contained 3·82 per cent of actual ammonia and all contain traces of iron. I also obtained in sample I. a strong reaction for uric acid.

This sample (No. I) resembles Peruvian guano in many respects, and leads to the conclusion that the difference between that and the American guano is mainly owing to circumstances of climate.

* Liebig's Report on Baker and Jarvis Guanos, Aug. 7th, 1860.

In some parts of the deeper deposit a light scale or crust has formed over the surface, which is generally very thin though occasionally hard pieces are found varying from half an inch to an inch in thickness. The thin scale is met with particularly where there is, or has been, any moisture, and, after showers, where pools of water have been standing for some time, such a crust appears on drying. There seems to have been a similar process in the formation of the thicker crust, for it is found only occasionally in places of which the dampness and general appearance indicate that water may have assisted at its formation.

The thinner pieces are found not only on the surface, but in certain localities form strata at various depths, usually about an inch apart, with intermediate layers of guano. These strata seem to have been formed at intervals during the accumulation of the guano deposit each one at some time having itself formed the surface and now marking a period in its age.

Each of the localities where these strata occur, although on opposite sides of the deposit are at the edges and immediately adjoining the marginal ridge already described and from their proximity to the shore it seems possible that these may have been subjected to occasional floods by high seas washing over the crown of the beach.

The following is an analysis of a thick and hard piece of crust found on the surface:—

Loss by ignition (water and little organic matter)	11·7500
Lime	40·93
Magnesia	·74
Phosphoric acid	40·47
Sulphuric acid	5·66
Loss and undetermined	·45
	100·00

The small amount of magnesia and the excess of sulphuric acid are points worthy of notice.

This crust is formed on Baker's Island only to a limited extent, but its existence there and character are interesting when compared with the Jarvis Island deposits, the better part of which is all crust and in which, as Johnson and Leibig have observed, much of the phosphoric acid is combined as the neutral phosphate of lime. The same is true of this crust of Baker's Island.

Before referring to the climate, birds etc. of this island, I will first give some description of Howland's and Jarvis' Islands.

Howland's Island.—About forty miles in a north northwest direction from Baker's, is situated Howland's Island in lat. 0° 51′ north and 176° 32′ west from Greenwich. It is about a mile and a half long by a half mile wide, containing, above the crown of the beach, an area of some 400 acres. The highest point is seventeen feet above the reef and ten or twelve feet above the level of the high tide. It trends N.N.W. and S.S.E. The general features of the island resemble those of Baker's. Its surface, at least on the western side, is somewhat depressed and much of it is covered by a growth of purslane, grass and other vegetation like that on Baker's Island, but considerably more abundant. Near the centre of the island there are one or two thickets of leafless trees or brushwood, standing eight or ten feet high and occupying an area of several acres. The tops of these trees, in which the birds roost, are apparently quite dead but the lower parts near the roots, show signs of life after every rain. The windward side of the island is formed by a succession of ridges composed of coral debris with some sand and shells, running parallel to the eastern beach, each one of which may, at earlier stages of the island's growth, have successively formed the weather shore. Occasionally among these ridges a sandy bed is met with in which some little guano is mixed. On the lee side there is also a sandy margin of considerable width. Bits of pumice and pieces of driftwood are scattered all over the island's surface.

The main deposit of guano occupies the middle part of the island and stretches, with some interruptions of intervening sand, nearly from the north to the south end. Its surface is even and in many places covered by a thick growth of purslane whose thread-like roots abound in the guano where it grows. The deposit rests on a hard coral bottom and varies in depth from six inches to four feet. The fact, already observed at Baker's, that vegetation flourishes most where the guano is shallow is also quite apparent here and the consequent characteristic difference between the guano of the deep and shallow parts is distinctly marked. The first variety, from the deeper part, is a fine pulverulent substance of reddish brown color, usually a little damp in its native bed and almost quite free from roots or fibers. The latter is of rather coarser texture, quite black and containing many delicate roots and fibers and much vegetable matter. The following analyses exhibit their comparative quality. No. 1 is of the deep part, No. 2 of the shallow part of the deposit.

	No. 1.	No. 2.
Moisture at 212° Fahr.	1·83	4·12
Loss by ignition	8·65	22·63
Insol. in HCl (unconsumed organic) matter	1·95	2·00
Lime	42·	36·90
Magnesia	2·65	1·24
Sulphuric acid	1·33	·58
Phosphoric acid	39·65	30·80
Carb. acid, chlorine and alkalies undeterm'd,	1·94	1·67
	100·00	100·00

It will be seen that the main difference in these samples is in the volatile matters present. Discarding the water and the organic matter, comparative analyses of the *ash* would vary but little.

Some interesting pseudomorphs occur buried in the guano of this island. Coral fragments of various species were found that had long been covered up under the deposit and in some of which the carbonic acid had been almost entirely replaced by phosphoric acid. In such I have found seventy per cent phosphate of lime. In many others the change was only partial and, on breaking some of these, in the centre was usually found a nucleus or *core* of coral still retaining its original hardness and composition, while the external parts had been changed from carbonate to phosphate which, though soft and friable, still preserved the structure and appearance of the coral.

Jarvis' Island.—Jarvis' Island is situated in lat. 0° 22′ south and long. 159° 58′ west from Greenwich. It is nearly two miles long by one mile wide, trending east and west, and containing about 1000 acres. Like Baker's and Howland's it has the general features of a coral island, but it differs from them essentially in the fact that it once contained a lagoon which has gradually been filled up with sand and detritus, while the whole island has undergone some elevation. It therefore presents a basin-like form, the surface being depressed from the outer edge towards the centre. It is encircled by a fringing reef, or shore platform, about 300 feet wide; from this a gradually sloping beach recedes, the crown of which is from eighteen to twenty-eight feet high, forming a ridge or border, of varying width, which surrounds the island like a wall, from the inshore edge of which the surface of the island is gently depressed.

Within this depression there are other ridges, parallel to the outer one, and old beach lines and water marks, the remaining traces of the waters of the lagoon, marking its gradual decrease and final disappearance.

This flat depressed surface in the centre of the island is about seven or eight feet above the level of the sea. It bears but little vegetation, consisting of long, coarse grass, mesembryanthemum, and portulacca, and that is near the outer edges of the island where the surface is formed of coral sand mixed with more or less guano. In the central and lower parts the surface is composed of the sulphate of lime, and it is on this foundation that the principal deposit of guano rests. This feature of Jarvis' Island is an important one to consider in studying the difference between the guano found on it and that on Baker's Island, for it readily explains the presence, in much of the Jarvis Guano, of the great excess of sulphate of lime, remarked by all who have investigated it, while the unequal mechanical mixture of the guano with the underlying sulphate accounts for the lack of uniformity in different samples.

In examining the foundation of the guano deposit on Baker's or Howland's Islands, by sinking a shaft vertically, the hard conglomerate reef rock is found directly underlying the guano. Resting on this foundation the guano has undergone only such changes as the climate has produced. On Jarvis' Island, however, after sinking through the guano, one first meets with a stratum of sulphate of lime (sometimes compact and crystalline, sometimes soft and amorphous) frequently two feet thick, beneath which are successive strata of coral sand and shells deposited one above the other in the gradual process by which the lagoon was filled up.*

Of the origin of this sulphate of lime there can hardly be any doubt. As the lagoon was nearly filled up, while, by the gradual elevation of the island, the communication between the outer ocean and the inner lake was constantly becoming less easy, large quantities of sea water must have been evaporated in the basin. By this means deposits would be formed containing common salt, gypsum and other salts found in the waters of the ocean. From these the more soluble parts would gradually be washed out again by the occasional rains, leaving the less soluble sulphate of lime as we find it here.

Some additional light is thrown on this matter by the different parts of the surface, which, though nearly flat, shows some slight variety of level. The higher parts, particularly around the outer edges, are composed chiefly of coral sand, either mixed with or underlying guano. Nearer the centre is a large tract, rather more depressed, forming a shallow basin in which the bulk of the sea water must have been evaporated, and whose surface (now partly covered with guano) is a bed of sulphate of lime, while, further, there is a still lower point, the least elevated of the whole, where the lagoon waters were, without doubt, most recently concentrated. This latter locality is a crescent shaped bed, about 600 feet long by 200 or 300 feet wide, having a surface very slightly depressed from the outer edge towards the middle. Around the borders are incrustations of crystallized gypsum and common salt, ripple marks and similar evidences of the gradually disappearing lake. The whole is composed of a crystalline deposit of sulphate of lime, which, around the borders, as already observed, is mixed with some common salt, while near the centre, where rain water sometimes collects after a heavy shower, the salt is almost entirely washed out, leaving the gypsum by itself. It is closely, but not hard, packed, and is still very wet. By digging 18 or 24 inches down, salt water may generally be found.

These facts help us to understand the varying conditions in which we now find the guano beds, since the most important part, and that from which the importations have thus far come, rests on a bed of sulphate of lime, of an earlier but similar origin to that just described above: a part rests on a coral formation, while still another part, covering a large tract, has been by the action of water mixed with coral mud.

* These horizontal strata were penetrated to a depth of about twenty feet. They were composed chiefly of fine and coarse sand with an occasional stratum of coral fragments and shells.

The first named deposit, lying on the sulphate of lime bed, has a peculiar character. It is covered by, or consists of, a hard crust that is from one-fourth of an inch to an inch and a half in thickness, beneath which lies a stratum of guano varying in depth from one inch to a foot. In many places where the guano was originally shallow the whole is taken up and formed into the hard crust which then lies immediately on the sulphate. This crust, when pure, is snow-white, with an appearance somewhat resembling porcelain, but is usually colored more or less by organic matter. Generally it is very hard, and strongly cohesive, though sometimes friable, and it lies unevenly on the surface in rough fragments that are warped and curved by the heat of the sun. It consists chiefly of phosphoric acid and lime, but, owing to the variable amount of sulphate of lime with which it is mechanically mixed, there is a lack of uniformity in different samples. Hence the percentage of phosphoric acid varies from over 50 per cent to less than 30 per cent.

The phosphoric acid and lime, moreover, are not combined in constant proportions, some existing as bone phosphate, the greater part, doubtless, in most specimens, as the neutral phosphate, and, possibly, a part as the superphosphate.

The following is an analysis of a piece of pure crust. The sample, in question, was a snow-white fragment, containing scarcely any organic matter.

Moisture at 212° Fahr.,	·12
Loss by ignition, (combined water with little organic matter),	9·62
Lime,	38·32
Sulphuric acid,	1·63
Phosphoric acid,	50·04
Undetermined and loss,	·27
	100·00

This presents a somewhat remarkable character. It appears to be a nearly pure di-phosphate of lime. After allowing to the sulphuric acid the requisite amount of lime, there remains enough of the latter to form ninety per cent of the salt $2CaO, HO, PO_5$ leaving an excess of about three per cent of phosphoric acid, which would suggest the possibility that a part of the phosphoric acid and lime may be combined as $CaO, 2HO, PO_5$.

So small an amount of sulphuric acid is also noticeable in a specimen of Jarvis guano which usually contains a large percentage of that acid, but in this case it is owing to the purity of the crust and the absence of mechanically mixed sulphate of lime.

Samples of Jarvis guano have been examined by many chemists, but their results are not always uniform, because, as I have already explained, their samples were *mixtures* of this crust and the underlying guano or gypsum. A number of analyses, made for commercial purposes by Prof. Johnson of New Haven, I find published in a guano pamphlet, issued by Mr. Webb as a trade circular. Prof. Liebig has also published a very complete analysis of Jarvis guano in his "Report on the Guanos of Baker's and Jarvis' Islands, Aug. 7th, 1860."

The following presents some of the results obtained by these two chemists:

	Liebig.	Johnson. Average of four samples.
Lime,	34·839	34·79
Phosphoric acid,	17·601	18·48
Sulphuric acid,	27·021	20·75

In Johnson's samples nearly the whole of the phosphoric acid is combined with the lime as $2CaO, HO, PO_5$, while Liebig finds for the above,

$3CaO, PO_5$,	17·397 per cent.
$2CaO, HO, PO_5$,	16·026 "

The formation of the neutral phosphate in this guano I think may be considered as a result of the action of sea water to which this part of the deposit has been subjected. It will be remembered that in describing the Baker's Island deposit I gave an analysis of a piece of crust found there, in which the phosphoric acid was likewise partly combined as the neutral salt. In that crust was also noticed a much larger percentage of sulphuric acid than is found in the guano from which it was formed; and, further, it was observed that on Baker's Island this crust only occurs in places of which the appearance and position indicate that water (probably from high seas washing over the crown of the beach) assisted at its formation. It seems to me probable, under these circumstances, that sulphates resulting from the evaporation of the sea water have been decomposed, and that the sulphuric acid has united with the lime of the bone phosphate, causing the formation of the di-phosphate of lime.

That this process may have been carried on to a much greater extent at Jarvis' Island, where much of the deposit has evidently long been acted upon by sea water, seems to me beyond a doubt.

A singular feature is presented by this crust in the formation of so-called 'hummocks,' an idea of which may be better obtained from the accompanying cuts than from words. These 'hummocks'

vary in diameter from one to ten inches and in height from half an inch to six or seven inches. The exterior is composed of the hard, phosphatic crust, while within each one, without exception, there is a central mass of soft, amorphous and nearly pure hydrated sulphate of lime. When one of these is cut through vertically the section shows a series of concentric layers above and around this central mass. The exterior is almost pure phosphate, and, proceeding from the outside towards the centre, each successive layer has less phosphate and more sulphate until the central mass is reached, which is almost pure sulphate. It is worthy of note that this hydrated sulphate of lime, which invariably fills the centre of a "hummock," is amorphous and exceedingly fine and soft, even when the underlying gypsum is crystalline. These hummocks are scattered over certain parts of the deposits and occur in close proximity to each other. In these places the deposit is invariably damp, and, usually, beneath each one may be found, mixed with the underlying sulphate, a black, earthy and damp substance containing much phosphate and some carbonate of lime. This black substance was, probably, coral mud, in which, as in the coral pseudomorphs of Howland's, the carbonic acid has been expelled and replaced by phosphoric acid, and this affords the only explanation that I can offer for this remarkable formation, namely, that in the chemical interchange that must have taken place between the soluble salts washed down from the guano on the surface, the sulphate of lime and the coral mud, there may have been an excess of carbonic acid liberated from the latter and replaced by phosphoric acid. The surface guano was probably wet and in a plastic state like thick mud, and the ascending carbonic acid, finding no other means of escape, and exerting an upward force, produced these hummocks, which have since become dry and hard.

In those parts of the crusted deposit where there are no "hummocks" the surface is usually a little higher and the deposit below drier than where the hummocks occur, and this would furnish a reason for their absence, since the hummocks could hardly be formed, as above explained, if the surface, for want of moisture, were not sufficiently plastic and yielding.

Thus this guano has not only been deprived of its ammoniacal salts, uric acid, etc., as have the deposits of Baker's and Howland's, but by its immediate contact with the gypsum has undergone further chemical and physical changes. Probably, too, the direct action of sea water has effected much by bringing together and mixing the guano with the bed on which it lay, and, by occasional inundations, exposing the whole alternately to the action of water and to the intense heat of the sun.* Thus it has been baked into a thick and hard crust whose chemical composition differs materially from the guano in its usual form.

* McKean's and Phœnix Islands, described below, are likewise old lagoons not yet elevated so high as Jarvis's. Their basins are sometimes flooded at high tides by several inches of water. Thus we may suppose that Jarvis, in an earlier stage of the process of elevation, was subjected to occasional floods, keeping in mind the fact before mentioned, that by digging now in the lower parts of the island salt water may be found at no great distance below the surface.

I have said that there was beneath the crust a stratum of guano of variable depth. Frequently it is wanting altogether, the whole being taken up in the crust and lying in immediate contact with the bed of gypsum. Where there is such a layer of guano it is variable in composition, being mixed with more or less sulphate of lime.

It generally contains from sixty to seventy per cent phosphate of lime.

I come now to speak of that part of the Jarvis deposit which rests on a *coral* foundation. This is of limited extent, but is of great interest because of its similarity to the Baker guano. It is about two feet deep; is a dry powder of dark brown color, of rather lighter shade than the Baker guano, owing to the presence of less vegetable matter. It contains very little coral sand mixed with it. The following is an analysis:

Moisture at 212° Fahr.,	5·02
Loss by ignition,	8·45
Lime,	42·17
Magnesia,	1·02
Sulphuric acid,	3·06
Phosphoric acid,	34·01
Carbonic acid,	·81
Insol. residue, (organic matter unconsumed by ignition),	·60
Chlorine, alkalies, iron, etc.,	4·86
	100·00

It is important to observe that while the greater part of the Jarvis guano, as already described, differs materially from the Baker, *this portion* of the Jarvis deposit has almost the same chemical and physical characteristics as the Baker or Howland guano. Resting like that on a coral foundation, it has been exposed only to like influences, while the Jarvis crusted deposit, above described, owes its peculiar character to its contact with the gypsum on which it lies and to the action of the sea water.

This gypsum or sulphate of lime is usually soft and amorphous, sometimes crystalline, and, at a depth of eighteen inches or two feet, occurs in hard, compact, crystalline beds. It is of a light snuff color, and where it underlies guano, is mixed with considerable phosphate of lime, which has been washed down from the surface. Similar deposits of sulphate of lime occur on many other elevated lagoon-islands of the Pacific, some of which I shall allude to below. I have also seen gypsum, of similar character and appearance, which occurs in "pockets" or small depressions in the now elevated portions of the coral reef at Oahu, Sandwich Islands, and doubtless due to the same source, the evaporation of sea water.

Unfortunately for the commercial interests of the Jarvis guano, the earlier cargoes (the first one or two) that were brought thence were selected without the aid of chemical analysis, and those in charge mistaking the gypsum for guano, sent home cargoes, the greater part of which was far from being worth the expense of transportation. The repetition of this error was promptly guarded against by sending a chemist to the island, but it required a longer time for the reputation of the article in the market to recover from the ill effects of such a mistake.

Climate.—The climate of these three islands is similar and very equable. The trade winds are almost constant, and blow in the summer from east by south to southeast, and, in the winter, from east by north to northeast. From October to February, inclusive, on Baker's, I did not observe a point of southing in the wind, while during the summer months there are long periods during which the wind is invariably from south of east. Calms are rare, especially those of long duration. Westerly winds have seldom been observed, except, occasionally, as light puffs on quiet, calm days. On one or two occasions only, in the winter, at Baker's, have any westerly winds of much force been recorded.

The sky is clear and cloudless. The temperature is exceedingly even, ranging from 76° at sunrise to 88° Fahrenheit at the hottest part of the day in the shade. In the sun at noon it stands between 95° and 100°.

Rain falls in light showers not infrequently. Heavy showers are rare and rainy days are unknown in my experience there. During four winter months at Baker's Island, from October 1, 1859, to February 15, 1860, rain fell twenty-three times, generally occurring in light showers or squalls, at intervals of a week or thereabouts, and a general coincidence between the times of occurrence of these showers and the changes of the moon from phase to phase has been observed, but this regularity is not so great, neither at this or other seasons, but that weeks have passed without a drop of rain.

During these four months the least of these showers, measured by conical rain gauge, amounted to $\frac{5}{1000}$ of an inch on a level, and the greatest on December 19, 1859, was $\frac{258}{1000}$ of one inch. From December 14, 1859, to December 20, 1859, inclusive, there fell $\frac{85}{100}$ of one inch. The total amount of the four months' rain was 1·840 inches, of which $\frac{85}{100}$ fell in December.

Although the amount of rain falling in the summer months is much less than that which falls in winter, there are, nevertheless, days in summer on which showers have fallen as heavy as any in the year.

Rain falls most frequently in the night and just before daybreak; sometimes by day, especially if the sky has long been overcast, a rain cloud passes over the island, but I have often observed the remarkable phenomenon of a rain squall approaching the island, and just before reaching it, separating into two parts, one of which passed by on the north, the other on the south side, the cloud having been cleft by the column of heated air rising from the white coral sands.

The position of these islands near the equator and their remoteness from any high land make them favorable places for studying the meteorology of this region. The equatorial current is a matter of great interest. It has a general direction of west southwest, and runs with a great velocity, sometimes exceeding two knots per hour, and, at times, suddenly changing and running quite as rapidly to the eastward.

During the winter months there are days when the swell is very heavy, and the surf breaks violently on the reefs, but in summer there is little or no surf, and especially on the lee side of the island, the water is very smooth. These periods in the winter occur usually at intervals of a few days and prevail during two or three and sometimes more days. In this connection I may allude to the shifting sands at Baker's, which, as I observed there, change their place twice in the year. The western shore of the island trends nearly northeast and southwest; the southern shore east by north. At their junction there is a spit of sand extending out towards the southwest. During the summer the ocean swell, like the wind, comes from the southeast, to the force of which the south side of the island is exposed, while the western side is protected. In consequence the sands of the beach that have been accumulating during the summer on the south side are all washed around the southwest point, and are heaped up on the western side, forming a plateau along the beach two or three hundred feet wide, nearly covering the shore platform, and eight or ten feet deep. With October and November comes the winter swell from northeast, which sweeps along the western shore and from the force of which the south side is in its turn protected. Then the sand begins to travel from the western to the southern side, and after a month or two nothing remains of the great sand plateau but a narrow strip, while on the south side the beach has been extended 200 or 300 feet. This lasts until February or March when the operation is repeated.

Birds, etc.—From fifteen to twenty varieties of birds may be distinguished among those frequenting the island of which the principal are Gannets and Boobies, Frigate Birds, Tropic Birds, Tern, Noddies, Petrels, and some game birds as the Curlew, Snipe and Plover. Of terns there are several varieties. The most numerously represented is what I believe to be the Sterna Hirundo. These frequent the island twice in the year for the purpose of breeding. They rest on the ground, making no nests but selecting tufts of grass, where such may be found, under which to lay their eggs. I have seen acres of ground thus thickly covered by these birds, whose numbers might be told by millions. Between the breeding seasons they diminish considerably in numbers, though they never entirely desert the island. They are expert fishers and venture far out to sea in quest of prey. The Noddies (Sterna stolida) are also very numerous.

They are black birds, somewhat larger than pigeons, with much longer wings. They are very simple and stupid. They burrow holes in the guano in which they live and raise their young, generally inhabiting that part of the deposit which is shallowest and driest. Their numbers seem to be about the same throughout the year. The Gannet and Booby, two closely allied species, (of the genus Sula), are represented by two or three varieties. They are large birds and great devourers of fish which they take very expertly, not only catching those that leap out of water but diving beneath the surface for them. They are very awkward and unwieldy on land, and may be easily overtaken and captured if indeed they attempt to escape at all on the approach of man. They rest on the trees wherever there is opportunity, but on these islands they collect in great groups on the ground where they lay their eggs and raise their young. One variety, not very numerous, has the habit of building up a pile of twigs and sticks, twenty or thirty inches in height, particularly on Howland's where more material of that sort is at hand, on which they make their nest. When frightened these birds disgorge the contents of their stomachs, the capacity of which is sometimes very astonishing. They are gross feeders, and I have often seen one disgorge three or four large flying fish fifteen or eighteen inches in length.

The Frigate Bird (Tachypetes Aquilus) I have already alluded to. It is a large rapacious bird, the tyrant of the feathered community. It lives almost entirely by piracy, forcing other birds to contribute to its support. These frigate birds hover over the island constantly, lying in wait for fishing birds returning from sea to whom they give chase, and the pursued bird only escapes by disgorging its prey, which the pursuer very adroitly catches in the air. They also prey upon flying fish and others that leap from sea to sea, but never dive for fish and rarely even approach the water.

The above are the kinds of birds most numerously represented and to which we owe the existing deposits. When the islands were first occupied they were very numerous but have since been perceptibly decreasing.

Besides these are the Tropic Birds which are found in considerable numbers on Howland's Island, but seldom on Jarvis' or Baker's. They prefer the former because there are large blocks or fragments of beach rock, scattered over the island's surface, under which they burrow out nests for themselves. A service is sometimes required of this bird which may, perhaps, be worthy of notice. A setting bird was taken from her nest and carried to sea by a vessel just leaving the island. On the second day, at sea, a rag, on which was written a message, was attached to the bird's feet, who returned to the nest, bringing with it the intelligence from the departed vessel. This experiment succeeded so well that, subsequently, these birds were carried from Howland's to Baker's Island, (forty miles distant), and, on being liberated there, one after the other, as occasion demanded, brought back messages, proving themselves useful in the absence of other means of communication.

There are several varieties of tern, those described above, however, being the only kinds that are found in very considerable numbers. The game birds, snipe, plover and curlew, frequent the islands in the fall and winter, but I never found any evidence of their breeding there. They do not leave the island in quest of prey but may be seen at low tide picking up their food on the reef which is then almost dry.

Some of the social habits of these birds are worthy of remark. The gannets and boobies usually crowd together in a very exclusive manner; the frigate birds likewise keep themselves distinct from other kinds; the tern appropriate to themselves a certain portion of the island; each family collects in its accustomed roosting place but all in peace and harmony. The feud between the fishing birds and their oppressors, the frigate birds, is only active in the air; if the gannet or booby can but reach the land and plant its feet on the ground the pursuer gives up the chase immediately.

Beside the birds there were but few original inhabitants found upon the islands. Among those I observe several varieties of spiders, at least two of ants, a peculiar species of fly that attaches itself to the larger birds, and the common house fly, which latter, however, may have been recently introduced. They as well as common red ants are exceedingly abundant.

Rats were found on all these islands, especially on Howland's, where they had become astonishingly numerous. It would seem that they had been carried there long ago, as there are no traces of recent shipwreck on the island, and had multiplied extensively. On Jarvis' Island they were much less numerous, and were probably brought by a ship that was wrecked there thirty years since. They subsist on eggs, and also, as I observed on Baker's Island, by sucking the blood of the smaller birds—the tern and noddies; and in this connection I may observe that these smaller kinds of birds, described above, are almost entirely wanting on Howland's, and their absence, I think, may be attributed to the depredations of the rats. These rats of Howland's Island were almost as numerous as the birds. They are of very small size, being hardly larger than a large mouse, and, I think, must have degenerated from their original state in consequence of the change of climate, food and condition of life. They had completely overrun the island, and on its first occupation by men were a great annoyance. For many nights in succession a barrel containing a few oats caught over 100, and I have known over

3,300 to have been killed in one day by a few men employed for the purpose.

A species of small lizard was also found in great numbers on Howland's Island, some specimens of which I had preserved in spirit, but the package containing them was lost on the voyage home.

Remains of former visitors.—There are some interesting traces on this (Howland's) island of former visitors or residents. Excavations and mounds in the centre of the island, among the thickets of brushwood, referred to above, are evidently the work of man. The most extensive of these excavations is several hundred feet long, and about one hundred feet wide, and ten or fifteen feet deep, forming a gully or ditch, on each side of which the sand and gravel is carefully banked up and kept in its place by walls laid up of coral stone, (blocks of beach and reef rock).

The trees themselves may possibly owe their existence here to the originators of these works, for the sides of this gully are covered by a growth of wood which, unless younger than the rest, would show the trees to be of more recent origin than the excavation.

It is said to be of a species called by the natives of the Sandwich Islands "Kou,"* which abounds on many islands of the Pacific. In the same vicinity there are also the remains of what were low, flat mounds of regular shape, formed of gravel and walled up all around, being about a foot high, and just such as I have observed are used by many South Sea Islanders for the foundation and floor of their houses. In another part of the island, near the western beach, some remains of a hut were found, and near by the fragments of a canoe, some pieces of bamboo and a blue bead. Here also was found, buried under a foot of sand, a human skeleton, the greater part of which, on being exposed to the air, crumbled to dust, leaving only two or three bones in condition to be preserved.

On the south end of the island there is a foot-path laid to cross a bed of coral debris or beach accumulations. The edges of the corals being rough, sharp and painful to the feet, the paths seems to have been laid for the convenience of passengers across this end of the island. It is several hundred feet long, made of flat, smooth stones, at convenient distances apart, for stepping from one to the other. They were evidently laid by hand, as they lie in a direction which forms nearly a right angle with the ridges made by the sea. It is probable that the originators of these works were South Sea Islanders. It sometimes happens that they are drifted off to sea by currents in their canoes, and such a party may have been thrown upon this island. No implements or other traces of civilized people have been found.

* Not to be confounded with "Koa," a species of acacia, and quite a different tree. I have seen the Kou alluded to somewhere as a species of *cordia*.

It is not unlikely that the lizards which abound on the inhabited islands of the Pacific were brought here by these people, and the rats, possibly, came from the same source.

Other Islands.—As already observed, the discovery of these deposits of guano, the extent and value of which were at first greatly exaggerated, induced fortune-seeking parties to explore the Pacific in the hope of finding many more of similar character. Under the act of Congress of 1856, granting American protection to the discoverers and occupants, under certain conditions, of such newly found deposits, nearly all the islands found on the charts within ten degrees north or south of the equator and within 150° and 180° W. were represented as possessing deposits of guano, and claimed by parties who evidently knew but little of their true condition.

A list, forty-eight in number, comprising nearly all of these islands, was published in the New York Tribune, in March, 1859, and was copied and discussed by Mr. E. Behm, in his interesting and valuable article, entitled "Das Amerikanische Polynesien," printed in Petermann's *Mittheilungen*, for 1859.

Of these islands, a number of which I have myself examined, it is safe to assert that some, although having a place on the charts, do not really exist, while many are of very doubtful existence; in some cases two or more names are applied to the same island; some are inhabited, others are covered with trees and vegetation, and very few have guano on them.*

* The following is the list referred to. Those named in the first column are islands whose existence and position is well authenticated, and the greater part of which I have myself visited. Those in italics are either known or said to be guano islands. Those marked with an asterisk are inhabited. Some of the islands mentioned in the second column are known certainly to exist, and are described by various navigators, while others are doubtful, but I am unable to add any *positive* information concerning any of them. The existence of those in the third column is considered as highly improbable, at least in the position commonly assigned to them.

I.	II.		III.
Baker's,	Caroline,	Danger, (6° 30′ N., 162° 32′ W.),	Arthur's
Jarvis',	Ann's,	Makin,	Favorite,
Howland's,	Staver's,	Matthew's,	Farmer's,
Malden's,	Flint, (10° 32′ S., 151° 05′ W.)	Barber's.	Sideron's,
Birnie's,	Baumann's,		Flint, (11° 26′ S., 162° 48′ W.)
Phœnix's,	Rogewein's,		Walker's,
Enderbury's,	Gronique,		Sarah Anne,
Christmas,	Frieuhaven,		Samarang,
Clarence,*	Quiro's,		David's.
Duke of York,*	Low,		
Penrhyn's,*	Pescado,		
Rierson's,*	Ganges,		
Humphrey's,*	Frances,		
Danger,* (10° 0′ S., 165° 56′ W.),	Mary Letitia's,		
Palmyra,	Kemin's,		
Sydney,	America,		
Mary's,	Prospect,		
Nassau.			

The following named islands, in particular, have been supposed, erroneously, as regards some of them, to have guano deposits:

		Latitude.	Longitude.
Phœnix Group.	McKean's,	3° 35′ S.,	174° 17′ W.
	Phœnix,	3° 40′ S.,	170° 52′ W,
	Enderbury's,	3° 08′ S.,	174° 14′ W.
	Birnie's,	3° 33′ S.,	171° 33′ W.
	Malden's,	4° 15′ S.,	155° W.
	Johnston's,	16° 53′ N.,	169° 31′ W.
	Christmas,	1° 53′ N.,	157° 32′ W.
	Starve, Starbuck or Hero,	5° 40′ S.,	155° 55′ W.

Of the above those of the Phœnix group are probably the most important. McKean's Island has been occupied since 1858, and several cargoes of guano of good quality have been brought from it to this country. It is a low island, circular in form, not exceeding three-fourths of a mile in diameter. Like Jarvis, it once contained a lagoon though not elevated so high above the sea. Its surface is consequently depressed, and is so much lower than the beach that at high tides the guano deposit is sometimes covered by two feet of water. As at Jarvis, a deposit of sulphate of lime has resulted from the evaporation of sea water in the basin, forming the foundation on which the guano rests; and owing, probably, to frequent inundations, the two have become so intimately mixed that the quality of much of the guano is considerably impaired. The better specimens contain about fifty per cent phosphate of lime mixed with much sulphate of lime. Much of the deposit is covered by a foot of coral mud, which has been spread out over the part adjacent to the beach.

Phœnix's Island is likewise very small, nearly circular, and less than a half mile in diameter. The centre is considerably lower than the beach, which is about eight or ten feet high, and it is often flooded at high tides. I was unable to land on this island, and my opportunities for observation were confined to shipboard. The guano deposit cannot be very extensive though said to be of good quality.

Enderbury's Island is described as an elevated lagoon, about eighteen feet high, three miles long by two and a half broad. It is said to contain deposits of guano, as is also its neighbor, Birnie's Island, of which I am unable to give any positive information, having never visited either.

Malden's is a large island, ten miles long, and said to be about forty feet high. I believe it is an elevated lagoon, but much of the guano deposit lies on the elevated ridge. Specimens which I have examined, though free from sulphate, were much adulterated by coral sand. Excepting McKean's, no cargoes have been brought from these islands just alluded to. From Johnston's Islands one or two cargoes have been brought to this country, the greater part of which proved, I believe, to be sand. These are described as three small islands (probably islets of one atoll) containing but little guano and that much mixed with coral sand.

Christmas Island is a well-known lagoon thirty miles long, trending east and west, having much vegetation. Much has been said by speculators of its rich deposits, but I have good reason to believe that there is no guano, worthy of mention, on the island. Samples that I have examined were chiefly coral sand.

Starbuck's, Starve or Hero Island is an elevated lagoon, and is worthy of mention because, like Jarvis', McKean's and other islands of similar structure, it contains a large deposit of gypsum. Its supposed guano I have found to consist of the hydrated sulphate of lime, containing about twelve per cent of phosphate of lime and colored by a little organic matter.

So far as my observation extends, all elevated lagoons have similar deposits of gypsum.

As regards the distribution of these phosphatic guano deposits I believe them, in this region of the Pacific, to be confined to latitudes very near the equator where rain is comparatively of rare occurrence. In latitudes more remote from the equator than 4° or 5° heavy rains are frequent, and this circumstance is not only directly unfavorable to the formation of guano deposits but it encourages vegetation, and when an island is covered with trees and bushes, the birds preferring to roost in them, there is no opportunity for the accumulation of guano deposits.

New York, August, 1862.

ART. XXI.—*Contributions from the Sheffield Laboratory of Yale College.*—III. *On Amblygonite from Hebron in Maine;* by GEORGE J. BRUSH.

A FEW weeks since Mr. John M. Blake, Ph.B., late assistant in this Laboratory, called my attention to a peculiar feldspathic looking mineral associated with the *lepidolite* from Hebron, Maine. Mr. Blake found on blowpipe examination that the mineral was extremely fusible, and that it gave a strong reaction for lithia, coloring the flame beautifully crimson. A further examination has shown it to be a phosphate of alumina and lithia, with a considerable amount of fluorine and some water. This composition, together with its physical properties, have led me to refer it to the rare species *amblygonite.*

Lepidolite occurs at Hebron in large masses in a coarse granite, and the *amblygonite* is found imbedded in this lepidolite, associated with albite, quartz, red, green and black tourmaline, and more rarely with cassiterite, and a peculiar compact variety of apatite containing minute prismatic crystals of a hair-brown mineral, which I have not yet been able to obtain in sufficient quantity to determine fully its characters.

The Hebron amblygonite is translucent, and has a white color, sometimes with a tinge of gray or brown. Cleavage equal, and perfect in two directions meeting at an angle of 73°–74° or 106°–107°. Lustre, on cleavage surfaces vitreous to sub-adamantine, and on the uneven fractured surfaces faintly greasy. Specific gravity 3·046. Hardness = 6. A small fragment held in the flame of an ordinary stearine candle fuses readily to an opaque white enamel; fusibility =2 on v. Kobell's scale. Heated in a closed tube, the mineral decrepitates slightly, and gives off traces of moisture; when the flame of a blowpipe is directed on the assay it fuses and acts upon the glass tube, producing a deposit of silica, just above the assay, and at the same time giving off water, which reacts acid, and etches the tube. In the forceps it imparts to the blowpipe flame a pure lithia red color without any traces of yellow; when the assay is moistened with sulphuric acid the flame is colored green on the edges, indicating phosphoric acid. The presence of this last substance was confirmed, by fusing a fragment of the mineral in a closed tube with metallic sodium, forming phosphid of sodium, which on treatment with water, evolved copious fumes, with the characteristic odor of phosphureted hydrogen. With salt of phosphorus it dissolves with effervesence to a clear colorless bead showing the absence of silica. With borax gives a transparent colorless bead in both oxydizing and reducing flame. With soda effervesces, and forms a difficultly fusible mass, which, even after addition of nitre, shows no trace of manganese. Heated with nitrate of cobalt it gives the blue color characteristic of alumina. It is only slightly acted upon by chlorhydric acid, but is readily dissolved by sulphuric acid with evolution of hydrofluoric acid; the solution gives reactions for alumina and phosphoric acid. These characters and reactions are sufficient to prove the identity of the mineral with Breithaupt's amblygonite. The only difference between the Hebron mineral, and the amblygonite from Penig in Saxony, is that the former contains so little soda that it imparts a pure lithia-red color to the flame, while the latter gives a flame tinged with yellow. As soon as I can obtain enough of the mineral for the purpose, I hope to examine the alkalies more minutely, with especial reference to rubidium and cæsium. These two new alkaline metals have been found in comparative abundance in the Hebron Lepidolite by Messrs. O. D. Allen and J. M. Blake of this Laboratory.

It is an exceedingly interesting circumstance that the Hebron mineral should occur associated with other minerals in a manner so perfectly analogous to the Saxon amblygonite, the latter being also found in a coarse granite and frequently imbedded in lepidolite containing quartz and tourmaline. The Hebron amblygonite occurs in irregular masses which in some specimens appear to be rough prisms of from half an inch to an inch in diameter. One of these gave an angle of 106° to 106° 30′.

Since writing the above, I have discovered amblygonite in specimens of lepidolite from the tournaline locality at Paris, eight miles from the Hebron locality.

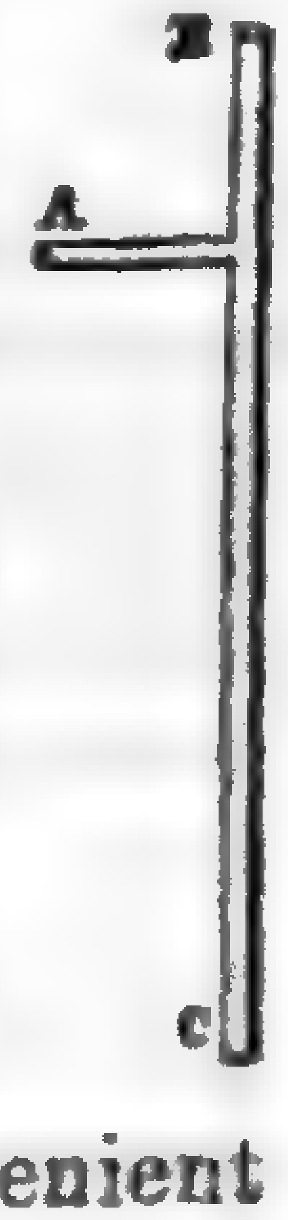
Sheffield Laboratory, Yale College, June 25, 1862.

Art. XXII.—*On a Constant Aspirator and Blower;* by M. Carey Lea, Philadelphia.

Various modes of producing a blast of air by means of the flow of water have been proposed for laboratory use. A somewhat complicated system involving the use of two fluids, mercury and water, was published in the Philosophical Magazine some years ago, and more recently an application by Dr. Sprengel of the well-known principle of the Catalonian blast furnace was described in this Journal.

It occurred to me that this principle might be made use of for aspirating, as well as for driving, a current of air, and experiment fully confirmed the idea. I have also modified the shape of the arrangement for catching the air described by Dr. Sprengel, introducing the current of water horizontally instead of vertically. I shall first describe the instrument intended for aspirating, and next the complete apparatus for all purposes.

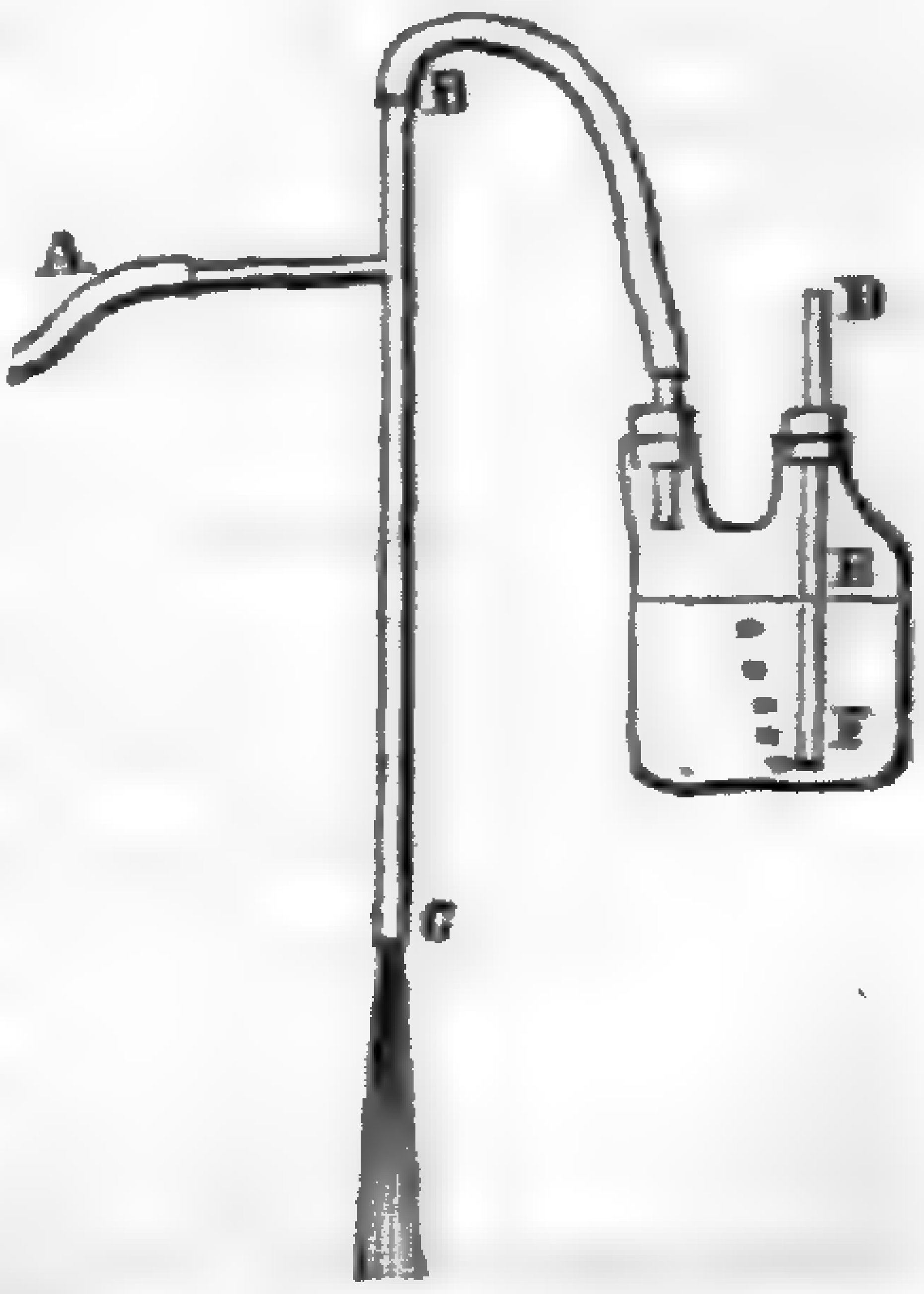
1.



The aspirator is extremely simple. It is nothing more than a tin tube represented by fig. 1, about two feet long, and four-tenths of an inch internal diameter, with a branch three-tenths of an inch in diameter and 4 inches long, inserted horizontally at a distance of four inches from the upper end.

For use, the tube is supported vertically in any convenient manner over a sink. An india-rubber tube communicating with a water-faucet is passed over the end of the smaller horizontal tube A. Another india-rubber tube connects the opening B with the apparatus through which air is to be drawn. As soon as the current of water is established, the air is aspirated. In the figure subjoined, the air enters at D after being aspirated through the Wolfe's bottle, or other apparatus through which it is desired to pass a current of air, enters the tin tube at B, and is drawn through with the water supplied by the pipe A and, escaping at C. The power of this instrument is such that with

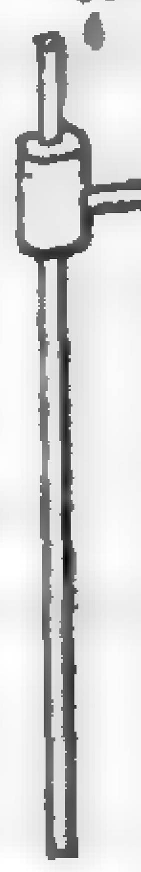
2.



one no larger than here described, a column of water of fifteen inches was easily displaced. The end C may be inserted into the funnel of a Liebig's condenser, and the water employed for cooling may be made at the same time to keep the aspirator in action.*

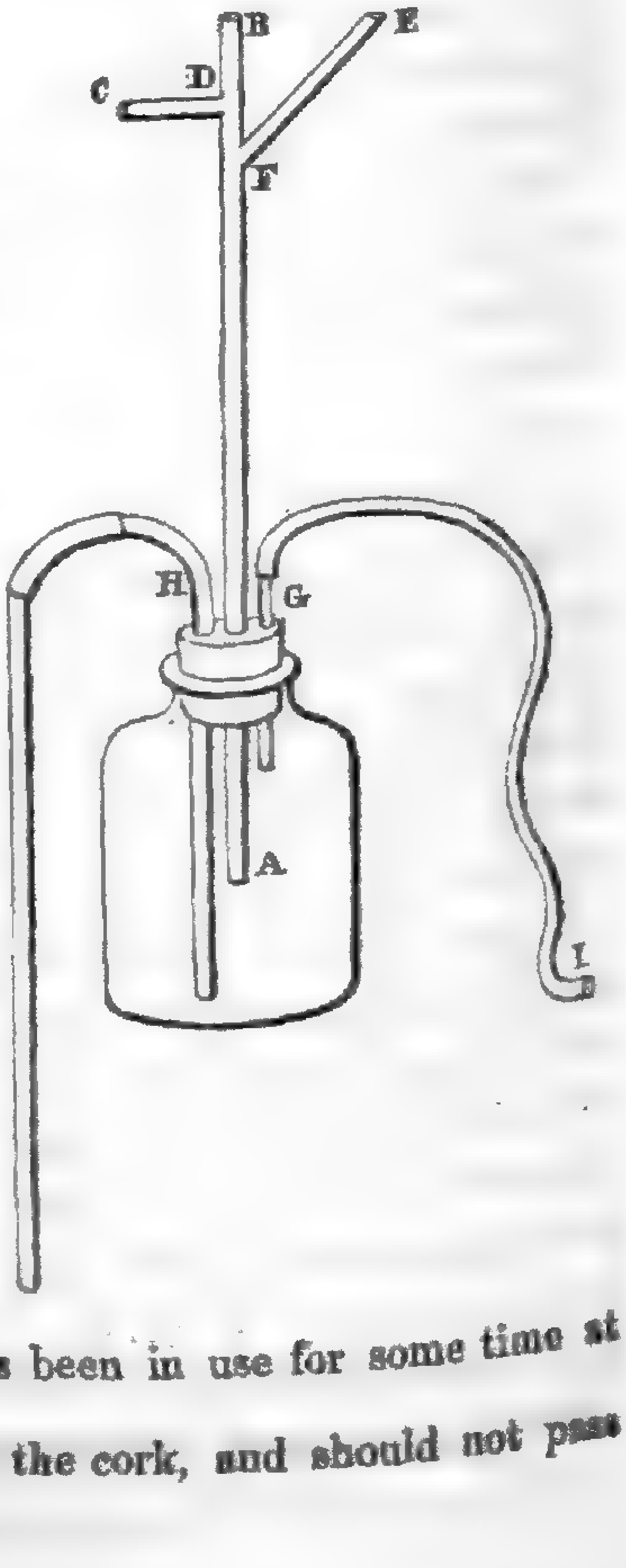
The aspirating tube (which may also at need replace the blowing tube subsequently to be described) may be easily made by the manipulator himself. A stout cork is bored parallel to its axis and to one side of the centre (not in the middle as in the figure,) and then a smaller hole is made at right angles to the first, communicating with it but not passing further. Three pieces of tube are then fitted into the cork, not allowing either to extend as far in as the junction. The cork is then brushed over with sealing wax dissolved in alcohol.

3.



It is, however, a more convenient plan to construct an apparatus capable of combining both the functions of blowing and aspirating. Such an arrangement is exceedingly useful, and can be made with very little trouble. For this purpose, a tin pipe, A B, about three feet in length and half an inch internal diameter, has two smaller pipes 4 to 6 inches long soldered into it. These are three-tenths of an inch in internal diameter. One, C D, is inserted at right angles, about four inches from the end; the other is inserted about an inch lower, and makes an angle of about 45°. The lower end of the tube passes through the cork of a tolerably wide-mouthed gallon bottle extending rather more than half way down. The tubes may be made of smaller calibre and shorter, even 18 inches answers very well, but the sizes given are those which I have found to afford the best results. The tin pipes can be made by any tinsmith in a few minutes.

4.



Two glass tubes also pass through the cork† of the bottle, a short small tube, G, over the outer end of which an india-rubber tube is passed, and a large tube, H, about half an inch in bore, extending to the bottom of the bottle. Its outer end bends over and is connected by six inches of india-

* This form of aspirator (the tube of glass) has been in use for some time at Sheffield Laboratory in New Haven.—Eds.

† The tube G should extend 6 or 8 inches above the cork, and should not pass below it as represented in the figure.

rubber tube with a straight tube of equal diameter. This last arrangement forms the siphon.

When the apparatus is to drive a blast, an india-rubber tube is connected with a hydrant and attached to the open end of the short horizontal branch of the tin tube. When the water is turned on, the india-rubber tube, G I, is closed for a moment with the finger and thumb. This starts the water through the siphon, and then a continuous and powerful blast of air is driven through the tube, G I, which may be attached to a blow-pipe, a Herapath burner, or be used in any way desired. The main point is this, that the siphon must be capable of carrying off a larger stream of water than that which is allowed to enter: in this way there is never more than an inch or two of water in the bottle, and some air escapes through the siphon, but without stopping its play. Otherwise the bottle may fill up and water be driven through G I. The proper balancing is easily attained and then the apparatus may be put in motion or stopped in a moment, and when in motion goes on indefinitely.

When the apparatus is to be used as an aspirator, the tube I is closed by inserting a glass rod, or passing over it a Mohr's stop-cock. B is closed by a cork and E is connected with the apparatus through which the current of air is to be drawn, or E may be closed and the connection made with B.

The arrangement here described for introducing the air and the water at the upper part of the tube was ascertained, after a number of experiments, to be that which was most effective. When the water is thrown horizontally into the vertical tube, it appears to carry with it a larger volume of air than when introduced perpendicularly or in an inclined position. Although the force of the current of air may be regulated to a considerable extent by diminishing or increasing the stream of water, yet it is to be observed that there must be a certain proportion between the stream of water and the size of the tube; a large tube ceases almost abruptly to produce any air-current when the stream of water is reduced below a certain point, and a small tube will not give an air-current of more than a certain force, no matter how great the stream of water. If it is desired that a single apparatus shall produce all degrees of action, a tin tube, like that before described but a little larger in all its parts, may be provided, with a cork fitting its upper extremity. Through a hole in this cork passes a thick glass rod, or tube sealed at one end, of the same length as the tin tube. The introduction of this cork and rod diminishes the effective calibre of the tube, and enables it to blow or aspirate a gentle current of air with a stream of water which would otherwise have failed to set the apparatus in motion; at the same time it can easily be removed when a powerful air-current is desired. The air in this case is derived wholly from the small inclined tube.

I have found this instrument to be of the greatest utility and convenience; so much so that I have two of them permanently fitted up in my laboratory. One valuable application is for getting rid of poisonous vapors. In any distillation, for example, the recipient or Wolf's bottle may be made to communicate with the open air or with a chimney, a cork with a tube may be inserted into the retort, or an extra tube through the cork of the flask in which the distillation is performed, and the flexible tube, G I, passed over it and a current of air be driven through during the whole operation. Or, if the products of distillation are valuable, the tube may be closed at I by one of Mohr's stop-cocks during the distillation, and at the end a current of air may be passed through the apparatus, sweeping it perfectly clean. In this way I have been able to dissolve oxyd of iridium containing osmic acid, in aqua regia, and drive off the osmic acid without suffering any inconvenience from the latter. The chemist who has once used this arrangement will find it so simple and efficacious that he will be led to employ it when manipulating with substances much less deleterious than osmic acid. It is very convenient in operations where chlorine is to be passed over or through substances, especially where the operation requires to be occasionally interrupted to examine the result.

For driving a blow-pipe, an apparatus of this sort, put together with a bottle and a few pieces of tube, is infinitely more convenient than the most expensive and cumbrous table blow-pipe, fed by a double bellows, especially when it is desired to ignite at high temperatures and for a length of time, the automatic nature of the instrument removing the necessity for working the bellows. A considerable degree of heat is easily obtained. A silver piece was laid on a fragment of brick and the flame of a Herapath burner, fed with a stream of air by this instrument, was turned down upon it: the coin withered up immediately. A similar coin was easily fused to a bright button in a porcelain crucible heated from below. Thick brass wire was melted off in drops, etc.

It is not necessary that the instrument should adjoin the blow-pipe or apparatus for which the air current is wanted. In one of mine, the current produced by the tube A B, two feet long, is carried through tubes about sixteen feet, and might easily be carried further without important loss of power.

The quantity of water required for keeping the apparatus in action depends of course upon the force of the current of air desired, but is never large. In an experimental trial it was found that with a consumption of water of 80 litres per hour, a stream of air amounting to 400 cubic centimetres per minute could be maintained, or in other words, a cubic metre (about a ton) of water would suffice to keep the apparatus in motion for twelve hours. This instrument may be appropriately called an *Æolus.*

Philadelphia, June, 1862.

ART. XXIII.—*Enumeration of the Plants of Dr. Parry's Collection in the Rocky Mountains*, (continued from vol. xxxiii, p. 411); by A. GRAY: with Supplements, by G. ENGELMANN and A. GRAY.

WE are happy to state that Dr. Parry, assisted by Mr. E. Hall, is now again in the Rocky Mountains, and at the last accounts was about to ascend Pike's Peak. An interesting botanical collection may be expected.

222. *Sambucus racemosa*, L. Apparently just the European plant, and a glabrous state of *S. pubens*, Michx.

223. *Symphoricarpus montanus*, H.B.K. New to our flora; well marked by its elongated corolla. *S. glaucescens*, H.B.K., appears, in probably authentic specimens, not to be really different.

224. *Lonicera involucrata*, Banks.

225. *Viburnum pauciflorum*, Pylaie.

226. *Vaccinium cæspitosum*, Michx. Just like the White-Mountain plant. "Strictly alpine."

227. *Vaccinium Myrtillus*, L. var. *microphyllum*, Hook. Fl. Bor. Am. Surely a remarkable variety of *V. Myrtillus*, the flowers as small in proportion as the leaves. According to Dr. Parry, it is the "usual alpine form, growing in closely branched masses, in the shade of stunted evergreens, taking the place of 228, which is found lower down, in pine woods. Fruit small, purplish, without bloom, mild and rather insipid in taste." Dr. Hayden gathered it on the Black Hills of the Platte.

228. *Vaccinium Myrtillus*, var.? The branchlets less strongly angled, and the leaves less reticulated and toothed than in the European *V. Myrtillus*. In the flowers, &c., it is as if intermediate between that species and *V. cæspitosum*. Fuller specimens, and the fruit, are wanted.

229. *Pyrola minor*, L. Collected by Fendler (No. 644) as far south as Santa Fé.

230. *Pyrola chlorantha*, Swartz. Dr. Hooker is right in his suspicion that the Greenland plant of Dr. Kane, referred by Durand to *P. chlorantha*, is *P. grandiflora*; but he is quite wrong, as I think, in referring *P. chlorantha* to *P. rotundifolia*, of which *P. grandiflora* is evidently a mere variety.

231. *Pyrola (Moneses) uniflora*, L. "In deep pine woods."

232. *Pyrola rotundifolia*, L. var. *uliginosa*. (*P. uliginosa*, Torr.) "In moist, shady woods; flowers rose-color." This is certainly connected with *P. rotundifolia* through *P. asarifolia*. To the synonyms of *P. rotundifolia*, Dr. Hooker might have added *P. occidentalis*, R. Br., *P. bracteata*, Hook., *P. picta*, Hook., &c., but should exclude, as I suppose, both *P. chlorantha* and *P. elliptica*.

233. *Pyrola secunda*, L.

234. *Gaultheria Mirsynites*, Hook. A rare and peculiar plant.

235. *Mimulus luteus*, L. A slender form.

236. *Collinsia parviflora*, Dougl.

237. *Veronica alpinus*, L.

238. *Gerardia aspera*, Benth. Valley of the Platte.

239, 240, 241. *Castilleia pallida*, Kunth. With red bracts, therefore verging to *C. miniata*, Dougl., which I conclude to be only a red-bracted variety of *C. septentrionalis*, Lindl., which is the form of *C. pallida*, with long, well-developed galea. For a revision of the genus, see Supplement III, infra.

242. *Castilleia pallida*, Kunth; nearer the type of the species (*C. Sibirica*, Lindl.) and *C. occidentalis*, Torr.

245. *Castilleia pallida ;* the taller and broader-leaved form with longer galea, like the plant of the White Mountains of New Hampshire, *C. septentrionalis*, Lindl.

243. *Castilleia breviflora. Euchroma breviflora*, Nutt. in herb. Acad., Philad.

244. *Castilleia integra*, Gray, l. c.

246. *Castilleia linariifolia*, Benth. The same as Fremont's plant.

247. *Orthocarpus luteus*, Nutt.

248. *Pedicularis racemosa*, Benth. in Hook. Fl., &c. Fine specimens of a rare and interesting species. "Grows in patches near the limit of trees. Leaves dark-green and shining. Flowers yellowish-white. July, August."

249. *Pedicularis bracteosa*, Benth. l. c. "Near the foot of alpine ridges; rare."

250. *Pedicularis Grœnlandica*, Retz. Obs. 4, t. 1. *P. surrecta*, Benth. l. c.; a form with larger flowers and longer beak. Torrey was quite right, as it appears, in referring this plant to *P. Grœnlandica*. Dr. Parry's specimens well accord with the figure of Retz, except that the beak is perhaps a little longer. Bourgeau collected it in the Saskatchawan district with the beak no longer than Bentham states it to be in the Greenland plant. In the Rocky Mountains it is "not uncommon on the borders of subalpine marshes, or of high alpine ridges; in the former stations tall and slender; in the latter shorter and stronger; flowers reddish-purple."

251. *Pedicularis Parryi*, (sp. nov. sect. *Rhyncolophæ*, Bunge, seu *Edentularum*, inter *Unciatas* et *Scapiformes*, Benth.): glaberrima; caule ultra-semipedali subnudo; foliis lineari-lanceolatis pectinato-pinnatipartitis petiolatis, caulinis 1–3 parvulis; segmentis linearibus acutis (ad summum 3 lin. longis) cartilagineo-serrulatis; bracteis parvis trifidis; floribus plurimis breviter pedicellatis in spicam angustam subconfertis; calycis membranacei 5-striati demum subinflati breviter 5-dentati dentibus lanceolatis integerrimis intus lanulosis; corollæ sordide flavæ galea angusta apice incurva sensim in rostrum longiusculum emarginatum haud denticuliferum subdecurvum labium inferius (lobis eroso-crenulatis) multo superantem producta; filamentis glaberrimis. "On alpine ridges. Flowers of a dirty or faded yellow," about half the size of those of the Siberian *P. compacta ;* the shape and size of the beak nearly that of *P. ornithorhynca*, which is apparently *P. pedicellata*, Bunge (*P. subunda*, Benth.). Spike naked, 2 to 4 inches long; the lower flowers rather sparse, on pedicels of $1\frac{1}{2}$ to 2 lines in length. The nearest affinity of the species is with *C. compacta*, Bunge, which is larger in all its parts, and

leafy-stemmed, the cauline leaves sessile, their much larger segments pinnatifid or incised, the flowers of the dense spike sessile, the calyx more inflated, the lower lip of the corolla nearly equalling the galea, and two of the filaments slightly bearded.

252. *Pedicularis procera,* (sp. nov. *Bicuspidatarum*): caule 1½–3-pedali crasso foliato superne cum spica densiflora 9–18-pollicari molliter pubescente; foliis glabris pinnatipartitis, (radicalibus sæpe sesquipedalibus pinnatisectis), segmentis lanceolatis laciniato-pinnatifidis, lobis serratis vel incisis; bracteis e basi ovato-lanceolata lineari-elongatis, inferioribus pectinato-pinnatifidis flores superantibus; calyce subæqualiter 5-fido, lobis lanceolatis integris tubo subdimidio brevioribus; corollæ (ultrapollicaris sordidæ virido striatæ) galea apice cucullata erostri truncata bidentata labium sub-patentem breviter trilobum vix æquante. "Shaded hill-sides, not uncommon in scattered localities." Collected also by Fremont in 1845, and in the Sandia Mountains further south, by Dr. J. M. Bigelow; but only in fruit. A striking species, quite distinct from any other known to me.

253. *Pedicularis Sudetica,* Willd., var. "High alpine; rare." The specimens accord very well with *P. Sudetica,* especially with Russian-American specimens, except the deeply emarginate summit of the galea is almost or quite edentulate. Bunge describes them as "breves triangulares basi latos;" but they are often subulate. I fancy that *P. nasuta* of Kamtschatka is very near Dr. Parry's plant. *P. Kanei,* of Durand, from Arctic Greenland, does not belong to *P. Sudetica,* as Dr. Hooker supposed, but to *P. lanata,* Willd.; which again, contrary to Bentham and Dr. Hooker, I must regard with Bunge as clearly different from *P. hirsuta.* It is much nearer another species which Dr. Hooker refers to *P. Sudetica,* viz. *Langsdorffii,* with which it has been confused, but it is perfectly edentulate. The teeth of the latter, however, are inflexed, and so may escape observation. All the continental American "P. hirsuta" I have seen belongs to *P. lanata.* All these species are well discriminated by Bunge in Ledebour's Flora Rossica.

254. *Synthyris plantaginea,* Benth. Wholly below the alpine region. The same as Fendler's No. 582. Radical leaves mostly obtuse or rounded (rarely at all cuneate) at the base; scape multibracteate. Flowers all short-pedicelled; sepals ovate, obtuse, villous-ciliate, becoming nearly glabrous with age. Corolla pale, very deeply 2-parted or even divided, the upper lip cuneate-obovate, entire or obscurely erose, a little exceeding the calyx, twice the length of the 3-lobed lower lip. Stigma capitellate.—The species of the genus need a complete revision, which I am unable now to attempt. In *S. Houghtoniana,* which I formerly had in cultivation, a great diversity was observed in the calyx, (varying from 2–3-parted to 5-parted), corolla, (2–4-parted, as described in the Manual, but the lips or divisions nearly of equal length, the lower not seen very short, as described in the Prodromus), stamens (either two or four), and even the ovary, which is occasionally tricarpellary.

255. *Synthyris alpina,* (sp. nov.): spithamæa; foliis radicalibus ellipticis seu ovalibus nunc subcordatis creberrime crenatis mox glaberrimis; scapo superne folioso-bracteato; spica brevi densa; sepalis lanceolatis extus præsertim ad margines cum bracteis longissime villosis; corolla

bipartita, labio superiori latissimo eroso, inferiori multo minori 2–3-partito, lobis angustis; stigmate capitato. "Growing in crevices of rocks, on the dividing ridge, at the elevation of 10,000 feet. Very different from No. 254, strictly confined to the high alpine region, with glossy foliage and a neat spike of pale blue flowers." Leaves $1\frac{1}{2}$ to 2 inches long, on slender petioles, rather strongly crenate, a little fleshy, very smooth, or early becoming so, as also the lower part of the scape. Bracts on the upper part of the scape ovate or in the spike lanceolate, sessile, and ciliate with very long woolly hairs. Spike only an inch long in flower, very dense, and very woolly; flowers nearly sessile; the corolla larger and more exserted than in *S. plantaginea.* Sepals in flower lanceolate and acute or acutish; but in a fruiting specimen broader and obtuser. Only two stamens seen, which, as in other species, are almost hypogynous.

256. *Chionophila Jamesii*, Benth. "On bare or grassy ridges of the snowy range, July. Flowers pale cream-color." A most interesting rediscovery, enabling us nearly to complete the account of this well-marked genus. The only known original specimen, and a very scanty one, is in the Hookerian herbarium, to which it was contributed by Dr. Torrey, mixed with *Pentstemon Jamesii*, and no specimen is extant in his own herbarium. But I presume that Dr. Parry's excellent specimens are of the same species, notwithstanding the striking discrepancies. The calyx, which gives the character to the genus, is gamophyllous almost to the summit, with 5 broad and short nearly equal teeth, considerably ampliate, thin, membranaceous, or even scarious. Corolla tubular, slightly dilated upwards, *nearly twice the length of the calyx*, and with a sort of *palate to the lower lip very densely bearded.* The original specimen must be in poor condition if this beard was overlooked. *Sterile filament much smaller and shorter than the others*, smooth. Stigma small, obtuse and entire. Radical leaves in the larger specimens 2 or 3 inches long, lanceolate-spatulate. Scape 2 to 4 inches high, *puberulent.* Flowers solitary in the axils of the small floral leaves, on very short and *ebracteolate pedicels.*

257. Vide after 261, 262.

258. *Pentstemon acuminatus*, Dougl. in Bot. Reg. t. 1285, var. *P. nitidus*, Dougl., Benth. *P. Fendleri*, Gray in Pacif. R.R. Rep., 2, p. 168, t. 5. "A wide-spread, variable species, with pale glaucous leaves and palish or bright blue flowers." Bentham describes *P. acuminatus* as with "filamento sterili filiformi glabro." But Lindley, in Bot. Reg., where the species was published, says "apice leviter pilosum, aduncum;" and his figure represents a large state of what I must consider the polymorphous species one form of which I published as *P. Fendleri*, and which is certainly *P. nitidus. P. cyananthus*, Hook. Bot. Mag., which in the Botany of the Mexican Boundary I had referred here, is however figured as having hairy anthers, like those of *P. glaber*, and with such a corolla as the latter has, but with narrow sepals. It may be a very well developed form of *P. glaber*, var. *alpinus.*

264. A narrow-leaved variety of the foregoing, clearly of the same species; "from plains east of Denver, with numerous bright blue flowers and narrow linear leaves." Similar specimens from Eureka, Mr. How-

ard, but only a span high, as well as others before me, (among them Geyer's No. 154, and some of Hooker's *P. acuminatus*, var. *minor*, from Carlton House), manifestly connect this species with *P. cæruleus*, Nutt., the oldest of all these names. *P. secundiflorus*, Benth., is another connecting form.

259. *Pentstemon glaber*, Pursh, var. *alpinus*. *P. alpinus*, Torr. in Ann. Lyc., N. Y. Only an alpine form of the next, with more attenuated sepals, the particular shape of which is inconstant in the genus. Dr. Parry remarks: "no doubt a variety of *P. glaber*, being almost exactly a dwarfed representative of that elegant species; and its alpine situation would sufficiently account for its stunted size."

260. *P. glaber*, Pursh, (*P. erianthera*, Fraser, Nutt.) "Common on dry hill-sides along the valley of Clear Creek; a splendid species, its large, brilliant, inflated, blue corolla streaked with reddish-purple stains." The name first published, with a character, ought to be restored for this species; since the anthers are but slightly hairy, in comparison with those of the section *Erianthera*, and are frequently glabrous, except a ciliation or mere denticulation at the margin of the valves. The beard at the top of the sterile filament is sometimes almost wanting, and sometimes sparsely extended downwards. I cannot doubt that the figure of *P. speciosus* in Bot. Reg., t. 1270, represents this species, and, returning to an old opinion in this regard, should reduce that to the present species.

261, 262. *Pentstemon glaucus*, Graham in Edinb. Phil. Jour. July, 1829, p. 348; Lindl. Bot. Reg. t. 1286. "Rather abundant at the foot of alpine ridges, above the limit of trees; the taller specimens from a lower elevation in the valley of Clear Creek. The more common form has pale cream-colored flowers with greenish stripes, and pale green leaves; there is a more rare, purple-flowered variety; both quite bilabiate." Small specimens of this are found in James's collection, mixed with *P. Jamesii*, Benth., and formerly confounded by Dr. Torrey with *P. albidus*,—to both of which they have some resemblance. The species, however, is more allied to *P. gracilis*, Nutt.; but it has a more inflated corolla even than *P. pubescens*, with which Bentham confounded it. The specific name is far from distinctive or good.

257. *Pentstemon humilis*, Nutt. in Herb. Acad. Philad.; apparently a reduced, alpine variety of *P. glaucus*, with shorter and rather less ampliate corolla. Specimens collected at Eureka by Mr. Howard (in herb. Acad. Philad.) ally Dr. Parry's plant with the *P. gracilis*, as figured in the Botanical Magazine. According to Dr. Parry it is: "the common mountain species, growing in tufts on rocky places; flowers bright deep blue; leaves glossy and bright green; plant varying from 3 inches to a foot in height."

263. *Pentstemon procerus*, Dougl. About a span high, and it is seldom very much taller. There was doubtless some mistake in the imposition of this name; but it is surely only a variety of *P. congestus*, with purple-blue flowers.

265. *Pentstemon albidus*, Nutt. A common species of the plains. *P. pumilus*, Nutt., is perhaps an alpine state of this. But Fremont's specimens, referred to *P. pumilus* by Bentham, appear to belong to a

remarkably dwarf and tufted, unpublished species, *P. cæspitosus*, Nutt., which Dr. Parry has detected the present season, and sent in a letter.

266. *Campanula Langsdorffiana*, Fischer.; Trauttv. & Meyer, Fl. Ochot., p. 60. *C. heterodoxa*, Bong. Fl. Sitch., an Vest.? Probably also *C. adscendens*, Vest, as it seems to be more allied, except in the size of the flowers, to *C. uniflora* than to *C. rotundifolia*. The calyx-lobes are linear-subulate from a broad base, nearly equalling the corolla, and more or less toothed. Additional specimens, needed to clear up the species, it is hoped may be obtained this summer. It is said to be "common in moist, grassy places on the borders of Upper Clear Creek. Flowers deeper blue than those of *C. rotundifolia*," far larger than those of the next.

267. *Campanula uniflora*, L.

268. *Campanula rotundifolia*, L.; alpine form, like that of the White Mountains of New Hampshire.

269. *Valeriana dioica*, L. (*V. sylvatica*, Richards., &c.)

270. *Galium boreale*, L.; a small form.

271. *Gilia spicata*, Torr. & Gray, ined. *Elaphocera spicata* and *E. affine*, Nutt. in herb. "Growing, with a deep tap-root, in the deep sandy bottoms of Bijou Creek, east of Denver. Flowers light cream-color or flesh-color; the whole plant exhaling a fœtid smell, like bone-filings."

272. *Phacelia* (*Eutoca*) *sericea*, Gray, Man. "A handsome subalpine."

273. *Cuscuta cuspidata*, Engelm.

274. *Polemonium pulcherrimum*, Hook.; with lobes of the corolla rounder. A form of *P. pulchellum*. "A charming alpine plant, adorning the high slopes with its deep blue, nodding flowers; whole plant beset with resinous glands, exhaling a strong odor of musk."

275. *Polemonium cœruleum*, L. "At lower stations."

276. *Polemonium pulchellum*, Bunge; nearly *P. Richardsonii*, Hook. & Arn. "Growing in shade at the farthest limit of bushy tree growth. Flowers delicate faded blue." The limits of species (if such they be) in this genus are indeterminate.

277. *Ipomœa leptophylla*, Torr. Sand hills of the Platte; a characteristic plant of the plains.

278. *Eritrichium aretioides*, DC. *Myosotis nana*, Torr. in Ann. Lyc. N. Y., vix Vill. "Rooting in granitic sand at the highest elevations of the snowy range; flowers of the richest cærulean blue." In flower, and with a little of last year's fruit, which, if normal, will distinguish this from the European *E. nanum*. The corolla is a little smaller. I suppose it to be *E. aretioides* of Arctic Russian America, &c., the fruit of which is undescribed. This Dr. Hooker regards as an arctic state of *E. villosum*. But the mature nutlets of our plant are perfectly smooth, and naked on the margins of the very obliquely truncate back.

279. *Primula angustifolia*, Torr. in Ann. Lyc. N.Y. "Associated with the last. Flowers dull red, changing to purple." An interesting rediscovery of one of James's plants.

280. *Collomia linearis*, Nutt.

281. *Collomia gracilis*, Dougl.

282. *Gilia pinnatifida*, Nutt. ined. The same as No. 655, Fendler.

283. *Gilia* (*Ipomopsis*) *aggregata*, Spreng. *G. pulchella*, Dougl.

284. *Mertensia alpina*, Don.; a loosely paniculate, branching, evolute variety. "Common in the valley of Clear Creek, on gravelly banks, growing in irregular clumps, 12 to 18 inches high; flowers dull blue, in May and June."*

285. *Mertensia Sibirica*, Don. pro parte. *Pulmonaria Sibirica*, Linn. & Pursh, quoad syn. Gmel. *Lithospermum denticulatum*, Lehm. Asperif. *L. Sibiricum*, Ledeb. Fl. Alt., & Ic. Pl. Fl. Ross. t. 207. *Pulmonaria denticulata*, Roem. & Schult., Cham., &c. *Mertensia dénticulata*, Don., DC., Ledeb. Fl. Ross. *Pulmonaria ciliata*, James, Torr. in Ann. Lyc. N. Y. 2, p. 224. *Mertensia ciliata*, Don., &c. Besides the greater smoothness, which is variable, this is distinguished from *M. paniculata* by the much shorter and blunt segments of the calyx, and the leaves are glaucescent beneath. No doubt the Linnæan name must be restored to this (the *Pulmonaria Sibirica* of Pallas resuming the name of *M. Pallasii*, Don.); for it is clearly the plant of Linnæus, and perhaps Pursh's from Canada (but more probably that is *M. paniculata*), and I suspect that Lehmann described his *Lith. denticulatum* from Siberian specimens. Certainly it is not known from Eastern "North America," unless from Labrador. H. Engelmann gathered it at Bridger's Pass in the Rocky Mountains, but my specimens have *M. paniculata* intermixed. Redowskian specimens from Kamtschatka, distributed by Chamisso, are of the present species. It is, writes Dr. Parry, "the common brookside *Mertensia*, found everywhere along the margins of ice-cold, dashing streams, up to the snow-line, delighting in situations where its pale foliage and delicate blue flowers are bathed in the spray. It grows to the height of 1½ to 3 feet; the stems succulent, the lower radical leaves large and cordate."

286. *Mertensia paniculata*, Don. A reduced and alpine, glabrate state, with much less acute leaves, of that form of *M. paniculata* which answers to *Pulmonaria lanceolata*, Pursh, and *P. marginata*, Nutt. (*M. marginata*, Don., and *M. lanceolata*, DC.) "Moist, grassy places, on the slopes of alpine ridges; flowers bright *alpine* blue." *M. paniculata* ranges from Hudson's Bay to Lake Superior, New Mexico above Santa Fé (626, Fendler) and northwestward. The foliage, calyxes, &c., vary, as in other species, from smooth or glabrous to hirsute, but the narrow and acute segments of the deeply 5-parted calyx are always hispid-ciliate. It obviously includes *M. corymbosa* and *M. pilosa*, Don., the *Lithospermum corymbosum* of Lehmann. Dr. Hooker has not seized the characters which distinguish the species from the foregoing.

287. *Mertensia alpina*, Don. *Pulmonaria alpina*, Torr. in Ann. Lyc. N. Y. "The small-flowered alpine *Mertensia*; flowers dull blue."

288. *Eritrichium glomeratum*, DC. Very fine specimens. "Common on gravelly hill-sides and rocky places from the foot of the mountains to the upper valleys."

289. *Phacelia circinata*, Jacq.

290. *Echinospermum floribundum*, Lehm. In fruit.

291. *Eritrichium crassisepalum*, Torr. & Gray, in Pacif. R.R. Exped. 2, p. 171. A young state, with broad leaves.

292–294, vacant.

* For a revision of the species of *Mertensia*, see Supplement, IV.

295. *Lithospermum pilosum*, Nutt. ex char. This is Fendler's No. 626 and Wright's 1562.

296. *Heliotropium* (*Euploca*, Nutt.) *convolvulaceum*, Gray.

297. *Paronychia*, n. sp. apparently, "—a single patch only, found rooting in a sandbar on Upper Clear Creek," not in sufficient good condition for description. We look for better specimens this year.

297. *Phlox Hoodii*, Richards, var. foliis rigidioribus vix lanatis. *P. rigida*, Benth.? *P. brevifolia*, Nutt. in Herb. *P. muscoides* and *P. bryoides* of Nuttall both belong to *P. Hoodii*.

299. *Gilia* (*Leptodactylon*) *pungens*, Benth.

300. *Silene acaulis*, L.

301. *Dracocephalum parviflorum*, Nutt. "The only representative of Labiatæ in the mountain region."

302. *Salvia Pitcheri*, Torr. Prairies in Kansas. This must be the *S. elongata* of Dr. Torrey in James's collection. It is intermediate between *S. azurea* and *S. farinacea*,—two Salvias which would seem to be distinct enough.

303. *Scutellaria resinosa*, Torr. in Ann. Lyc. N. Y. Upper Platte.

304. *Gentiana Parryi*, sp. nov., Engelm. in Trans. St. Louis Acad., 2, p. t. 10. "Near the foot of alpine slopes." This is, says Dr. Engelmann, "a very handsome species, growing in tufts, each stem bearing several large, purplish-blue flowers with bifid folds, and enclosed by a pair of boat-shaped bracts. Leaves rounded, fleshy, glaucous. Nearly allied to *G. calycosa* and *G. Menziesii*, which, however, have single flowers, without the calyculate bracts peculiar to our species, and to the Siberian *G. septemfida*, with long folds slit into numerous bristling lobes." *Engelm.* The plant of Kreusfeldt, in Gunnison's Expedition, referred to *G. affinis* in the second volume of the Pacific Railroad Report, is of this species, but with narrower leaves, and Fremont's No. 360 (1845) is a small-leaved form of it, which also occurs in Mr. Howard's collection (Herb. Acad. Philad.), in one instance with a six-lobed corolla.

305. *Gentiana frigida*, Hænke, var. *algida*, Griseb. "Abundant on high alpine slopes, in moist places, growing in small tufts among Grasses and Carices." "Apparently an intermediate form between the European *G. frigida* and the Siberian *G. algida*. Stems lower than in the latter, only 4 or 5 inches high; the leaves narrower; flowers fewer and closely sessile; calyx often partly slit; lobes of the corolla very acute, greenish blue, reddish-brown in the dried state, punctate, the folds truncate and crenate." *Engelm.* This is also in Mr. Howard's collection. New to America, but found as near as Kamtschatka.

306. *Gentiana prostrata*, var. *Americana*, Engelm. l. c. t. 9, fig. 10–15. "A very small form, single or with few horizontal branches, 1–1½ inches high, found with No. 309. Distinguished from the European and Asiatic forms by the small, 4-parted deeply blue flowers, nearly entire folds, and oblong-linear capsule, attenuated at the base into a short stipe. Chamisso collected the same form in Russian Arctic America." *Engelm.*

135. *Gentiana humilis*, Stev., Engelm. l. c. fig. 1–5. *G. Fremontii*, Torr. in Frem. Rep. "Along the moist grassy banks of Upper Clear Creek, with *Polygonum viviparum*, almost hidden among the grass. Whole plant succulent, fragile, of a pale sickly color: flowers greenish

with white folds."—"Many leafy, one-flowered, erect or ascending branches, 2-5 inches high, from the base. Distinguished from the allied species, and especially from *G. prostrata*, by its larger rosulate lower leaves, which, as well as the oblong-linear cauline leaves, are cuspidate and often mucronate. The capsules on the taller branches are more or less exsert, on the lower ones I find them often enclosed, or bursting sideways through the integuments. Siberian specimens are absolutely identical with the Rocky Mountain plant." *Engelm.*

307. *Gentiana acuta*, var. *stricta*, Griseb. "Rather common in shady pine woods and moist places on Upper Clear Creek. In shaded places the leaves are pale-green on both surfaces, broad and mostly obtuse; the flowers very pale-blue; in more open localities the leaves are dark-green above, pale below, narrower, the upper most acute, the flowers darker." "Stems a foot high, leaves 1–1¾ inches long, 3–7 lines (the lower ones) wide. Flowers about ½ inch long, always 5-parted; lobes of calyx very unequal, the two longer and broader ones exceeding the tube of the corolla; lobes of the corolla acutish or almost obtuse, half as long as the tube. From Drummond's northern specimens in Herb. A. Gray, our form is distinguished by the less acute leaves, and especially by the larger calyx. A specimen from Lower Canada in Herb. A. Gray, probably representing Michaux's plant, has very acute leaves, smaller flowers, a more regular 4-parted calyx, and very acute lobes of the corolla. The very nearly allied *G. Amarella* of northern Europe has the corolla much less deeply divided, with quite obtuse lobes." *Engelm.*

309. *Gentiana acuta*, var. *nana*, Engelm. in Transact. St. Louis Acad., 2, t. 9, fig. 6–9. "In the higher alpine regions, together with *G. prostrata*, in masses of *Silene acaulis*." "A diminutive form, 1½–2 inches high; flowers few, smaller; lobes of 4–5-parted corolla obtuse; beard consisting of few distinct fibres." *Engelm.* This, from the obtuse lobes of the corolla, would appear to confirm Dr. Hooker's view that *G. acuta* is a form of *G. Amarella*, represented in Lapland by *G. lingulata*, Ag. Some specimens distributed with No. 309 are the ordinary *G. acuta* in a depauperate form, with acute lobes to the corolla.

308. *Swertia perennis*, L.

310. *Frasera speciosa*, Dougl. "A very strict and small-flowered form, with ternate, linear-lanceolate, 7–9-nerved cauline leaves, and linear elongated lobes of calyx rather exceeding the corolla. Fendler's New Mexican specimens (No. 686) have large and obtuse radical leaves (12–16 inches long, 4–5 inches wide); even the cauline leaves are broadly oval, only the uppermost being lance-linear; the inflorescence is loose, and the flowers much larger. Dr. Parry's plant resembles more the figure in Hooker's flora. The cup uniting the base of the stamens is ciliate on its edge in this species. *Frasera Carolinensis* has large, obovate-spatulate, feather-veined radical leaves. *Engelm.*

311. *Primula Parryi* (sp. nov.): *P. nivalis* formæ eximiæ similis, nisi foliolis involucri subulatis seu linearibus quam pedicelli elongati triplo brevioribus; calyce glanduloso (lobis lato-lanceolatis acutis) tubum corollæ rubræ adæquante; corollæ lobis rotundatis obcordato-bifidis.—Limb of the corolla an inch in diameter. Pedicels one to nearly two inches long. This magnificent Primrose needs to be compared with Ledebour's

P. pycnorhiza (a very rare and little known species from the Caucasus, which, however, seems too like *P. algida*), and it doubtless lies between that species and *P. nivalis:* but it can hardly be referred to either, although possibly, all these species may be found to merge in one. Dr. Parry remarks that "This fine species is quite constantly met with on the borders of alpine streams near the snow line; its knotted fibrous roots matted together, and constantly bathed in ice-cold water. Its usual height about 12 to 18 inches: flowers of a deep *carmine red* (fading to purple), with a slight primrose odor; leaves glossy on the upper surface, pale green. It flowers in July. It must be quite extensively diffused in its peculiar localities, and it is a wonder it has not been found before. In my sketch map I have named one mountain stream *Primrose* Creek, on account of the abundance of this plant."

312. *Dodecatheon Meadia*, L. A slender, few-flowered variety of this polymorphous species.

313. *Androsace septentrionalis*, L. Both alpine and in the valleys.

314. *Phacelia Popei*, Torr. & Gray in Pacific R. R. Rep. 2, p. 172, t. 10. "Whole plant of a brownish-green color, often robust, 8 to 15 inches high."

315. *Eriogonum umbellatum*, Torr. in Ann. Lyc. N. Y., 2, p. 241, & in Sitgreaves, Rép. t. 12. Flowering specimens: flowers bright yellow, as they are in Hayden's and other specimens.

316. The same as 315 in fruit; the perianth changed to pale yellow turning brownish.

318. The same species, apparently, as the two foregoing, but the flowers in the fine and well preserved specimens are obviously white or cream color. Which form is the original of James's collection, I am unable now to determine. Torrey's figure, in Sitgreaves' Expedition is a good one, but there is nothing answering to it in the letter-press. The rays of the umbel are more numerous, slender, and simple in all these specimens than in Hooker's figure of *E. stellatum;* but a Douglasian specimen appears to belong to this species.

317. *Eriogonum flavum*, Nutt.

319. *Eriogonum alatum*, Torr.

320. *Eriogonum annuum*, Nutt.

321. *Eriogonum effusum*, Nutt. Flowers white: those of *E. microtheca*, Nutt., are yellow.

322. *Polygonum tenue*, Michx. Hillsides, near Central City.

323. *Montelia tamariscina*, Gray? male plant.

324. *Euphorbia marginata*, Pursh.

325. *Croton* (*Hendecandra*) *muricatum*, Nutt.

326. *Frœlichia Floridana*, Moq.

327. *Cycloloma platyphyllum*, Moq.

328. *Eurotia lanata*, Moq. *Diotis*, Pursh.

329. *Euphorbia hexagona*, Nutt.

330. *Euphorbia petaloidea*, Engelm.

331. *Solanum rostratum*, Dun. *S. heterandum*, Pursh.

332. *Polygonum viviparum*, L.

333. *Polygonum Bistorta*, L., var. *oblongifolium*, Meisn.

334. *Oxyria digyna*, R. Br. "Common in the alpine region; the specimens collected are from a lower elevation, and are large."

335. *Asclepias verticillata*, L., dwarf form.
336. *Abronia* (*Tripterocalyx*) *cycloptera*, Gray.
337. *Abronia fragrans*, Nutt., figured in the second volume of the Pacific Rail Road Reports.
338. *Acer glabrum*, Torr., var. *A. tripartitum*, Nutt.
339. *Betula alba*, L. var., *glutinosa*, forma *latifolia*, Regel, or nearly.
340. *Alnus viridis*, DC.
341. *Salix glauca*, L. Masc.
342. *Salix cordata*, Muhl. ?
343. *Salix reticulata*, L. (*S. sericea*, Pursh.) Alpine.
344. *Salix discolor*, Willd.
345. *Populus tremuloides*, Michx.
346. *Lloydia serotina*, Reich. *Anthericum*, L.
347. *Calochortus venustus*, Benth., ex Torr. The species greatly need revision and diagnosis.
348. *Streptopus amplexifolius*, DC.
349. *Leucocrinum montanum*, Nutt. in Gray, Melanth., p. 110. A rare plant, one of the many which go to demonstrate the futility of an ordinal separation of the *Melanthieæ* from the *Liliaceæ*. Also collected by Mr. Howard. The specimens in both cases not in good state for examination.
350. *Allium cernuum*, Roth.
351. *Zygadenus glaucus*, Nutt.
352. *Corallorhiza innata*, R. Br.
353. *Listera cordata*, R. Br.
354. *Calypso borealis*, Salisb. In spruce woods; not uncommon.
355. *Platanthera obtusata*, Lindl.
356. *Platanthera hyperborea*, Lindl. To this, as I suspected long ago (in Ann. Lyc. N. Y., when endeavoring to distinguish this species from the next), belongs the *Habenaria dilatata* of Hooker's Exot. Fl., t. 95. "Flowers greenish."
357. *Platanthera dilatata*, Lindl. *Orchis dilatata*, Pursh. *Habenaria dilatata*, Gray, in Ann. Lyc. N. Y. "In subalpine swamps." Flowers white. Since my observations upon these two species, made almost thirty years ago, I have often, like other botanists, when superficially examining dried specimens, been tempted to re-unite them. This Dr. Hooker has recently done, in his memoir of Arctic Plants. It is quite as easy to err in combining as in unduly separating species. Having recently examined the two alive, in view of their arrangements for fertilization, (which I may elsewhere describe), I would now state that the structure and disposition of their genitalia and the shape of the gorge of the flower is so different, that, while *P. dilatata* (like its congeners in general) can rarely if ever self-fertilize, *P. hyperborea* readily does so, much in the mannar of *Ophrys apifera* as recently illustrated by Darwin; the former has almost parallel anther-cells, with a narrow stigmatic surface and a sort of trowel-shaped beak between their bases and below, within the narrow gorge, made by the erect position and connivence of the base of the labellum and other petals, are the large and elongated, linear-oblong, viscid discs or glands. In *P. hyperborea* the labellum, spreading from the base, leaves an open gorge, the more exposed stigma is broad and transverse (as figured by

Sir Wm. Hooker in Exot. Fl., t. 95, under the name of *Habenaria dilatata*), the glands are smaller and orbicular, the beak wanting, the anther-cells more divergent, and, from the curvature of the flower, more overhanging, and the stalks of the pollinia very attenuated and weak. Thus disposed, the pollinia very commonly fall out of the anther-cells while the tip of the labellum is still engaged under the point of the upper sepal and petals, or even in the closed buds; and when the labellum is disengaged and becomes recurved, or even before, the pollinia are apt to topple over and fall upon the broad stigma beneath.* That our *P. dilatata* is the *Orchis dilatata* of Pursh I am assured. Our green flowered species should be re-compared with the Iceland *P. hyperborea*, and with this the Iceland *Orchis Kœnigii* (described originally by Retz as with "*labio tripartito*," but referred by Linnæus to *O. hyperborea*, and annexed by Lindley to a probably quite different species from Unalaschka) should be collated.

358. *Juncus castaneus*, Sm.; an alpine form.

359. *Juncus triglumis*, L. With the last.

360. *Juncus arcticus*, var. *gracilis*, Hook.? Alpine; too young.

361. *Juncus Menziesii*, R. Br. ex Hook.

362. *Luzula parviflora*, DC.

392. *Luzula spicata*, DC., var., approaching *L. Peruviana*. Alpine.

363. *Poa alpina*, L.? "At the foot of the snow banks; July."

364. *Munroa squarrosa*, Torr. *Crypsis*, Nutt. Deep sand beds, east of Denver.

365. *Calamagrostis sylvatica*, Trin. "Dry bottoms of Clear Creek; July.

368. A purple variety of the above (nearly *C. purpurascens*, R. Br.), in an older state. "Alpine; August."

366. *Muhlenbergia gracilis*, Trin. *Calycodon montanum*, Nutt. Pl. Gamb., ex Thurber.

367. *Aira cæspitosa*, var. *arctica*, Trin. *Deschampsia brevifolia*, R. Br. Alpine.

369. *Buchlöe dactyloides*, Engelm.; both sexes of the Buffalo-Grass. "Plains of the Platte."

370. *Boutelona oligostachya*, Torr.

371. *Eriocoma cuspidata*, Nutt. *Stipa membranacea*, Pursh.

372. *Aira cæspitosa*, L. "Alpine ridges."

373. *Festuca rubra*, L. Too young; "alpine ridges."

374. *Poa laxa*, Hænke.

375. *Poa nemoralis*, L., or one of the species referable to this. "Alpine ridges."

* Another North American Orchid, which self-fertilizes, and that without the aid of insects, is *Gymnadenia tridentata*. In this the anther-cells dehisce while the flower-bud is still unopened, and some of the packets of pollen (in this species easily separable from their connections) will be found to have reached stigmatic surfaces, here unusually situated; and I have found an abundance of pollen-tubes to be produced, before the flower had opened. Yet the arrangements for the removal of the pollinia by insects are as perfect as in the species which depend upon insect-aid, and while a portion of the pollen-packets fall away at an early period, the rest remain attached in the usual manner. The plant requires, and will well reward, a critical study.

379. *Poa andina*, Nutt. in herb. Acad. Philad. "Upper Clear Creek."

376. *Poa arctica*, R. Br.? (*P. flexuosa*, Wahl.); a form of *P. laxa?* "Alpine ridges."

377. *Trisetum subspicatum*, Beauv. "Alpine ridges."

378. *Bromus Kalmii*, Gray, Man. "S. Clear Creek; July."

380. *Festuca ovina*, L. "Alpine."

381. *Triticum ægilopoides*, Turcz. Perhaps a variety of *T. caninum*, as Ledebour has it. "Alpine."

382. *Phleum alpinum*, L. "Subalpine."

383, 387, 389. *Carex atrata*, L., var. *nigra*, Boott. (*C. nigra*, All.), except that the perigynia are light-colored. From the var. *ovata*, Boott (*C. ovata*, Rudge), they differ in the sessile and crowded spikes.

384. *Carex rigida*, L.

385. *Carex incurva*, Lightf., with a dense, globular head.

386. *Carex capillaris*, L.

388. *Carex aurea*, Nutt.

390. *Carex lanuginosa*, Michx. S. Clear Creek.

391. *Carex festiva*, Dewey. S. Clear Creek.

393. *Carex bromoides*, Schk.? Too young.

394. *Woodsia obtusa*, Torr. "Subalpine."

395. *Cystopteris fragilis*, Bernh.

396. *Allosorus* (*Gymnogramme*) *acrostichoides;* referred by Sir Wm. Hooker to *A. crispus*. "Alpine."

397. *Notochlæna dealbata*, Kunze. Near Idaho.

[Concluding observations in next number.]

ART. XXIV.—*Abstract of a discussion of the Horizontal Component of the Magnetic Force, from observations made at the Girard College Observatory, Philadelphia, in the years* 1840–'41–'42–'43–'44–'45; by A. D. BACHE, LL.D., F.R.S., Mem. Corr. Acad. Sc. Paris, Sup't, U. S. Coast Survey.

PART IV.—*Investigation of the eleven* (*or* ten) *years period and of the disturbances of the horizontal magnetic force.*

IN the full paper, notes of all the changes in the instruments from accidental derangement or otherwise, and of the corrections applied, follow this statement, as an introduction to Table No. I, which contains the recapitulation of the monthly mean readings of the bifilar magnetometer, corrected so as to present a continuous series and with the observed temperatures.

In applying the results, by equations of the form involving the change of temperature and of epoch, the latter changes including the loss of magnetism in the bar and the change of the horizontal force of magnetism, it was found expedient to omit the results of the first year of the series. The remaining four years results gave 16·5 scale divisions for the monthly effect of the change of magnetic horizontal intensity, and of the magnetism of the bar and 1·8 divisions for the effect of one degree of temperature of Fahrenheit's scale.

A new term involving the difference between the square of mean epoch and any single epoch with a coefficient, was found to improve this result giving for the monthly change 17·6 scale divisions, for the effect of one degree of Fahrenheit, 1·62 divisions, and for the coëfficient of the term involving the square 0·31. This gives for the annual progressive change 211·2 scale divisions, and for the effect of one degree of the thermometer, $q = 1{\cdot}62 \times 0{\cdot}0000365 = 0{\cdot}0000591$ in terms of the magnetic moment of the bar. This agrees with the best direct determinations, being those in which the Observatory was alternately heated and cooled.

To test these results a combination of the six warmest months with the six coldest by alternate means was made, beginning with May, 1841, and ending with April, 1845. The result for correction for temperature was 1·3 scale divisions for 1° Fahrenheit, confirming the foregoing. In reducing the observations 1·5 scale divisions has been used as the correction for each degree of Fahrenheit's scale, $q = 0{\cdot}0000548$ in terms of the horizontal force and the observations are reduced to 63°·0 Fahrenheit.

This discrepancy between the results of the direct experiments for the correction of temperature, and those derived from the general discussion of all the observations occurred also in the Toronto observations, in those at Makerstoun, and in those at St. Helena, and has been the subject of comment by General Sabine, Mr. Broun, and Dr. Lamont.

Table No. II, of the full memoir, contains the results in scale divisions after correcting each value of the former table for temperature.

Table No. III gives the resulting monthly means for each year of the whole series from 1840–'41 to 1844–'45 both inclusive.

The corrections for regular progressive changes of readings in the horizontal force, and for certain irregular changes are next carefully studied and appended in Table No. IV which shows the monthly means of the bi-hourly and hourly readings of the bifilar magnetometer referred to 63°·0 Fahrenheit, and corrected for irregularities in the progressive change. The monthly means for each year and for the five years are given in abstract in Table No. V.

The differences in the successive annual means indicate that the progressive change may be assumed to have been uniform from year to year, and, applying the usual method, an annual progressive change of 220 scale divisions is the result.

From a study chiefly of other independent observations, the total annual change of horizontal magnetic force is determined to be 16·5 scale divisions, hence of the 220 scale divisions of change shown by the observatory bifilar, 203·5 is due to the loss of magnetism of the bar.

Separation of the larger disturbances.—The observations having been referred to a uniform temperature and corrected for progressive change, Peirce's criterion was applied separately to each month. For this purpose a systematic application was made extending over the whole series of observations commencing with the hour 0 and the month of July, next with hour 2 and August followed by hour 4 and September, and so on in regular progression. This process eliminates from the result the diurnal variation and the annual variation of the disturbances themselves. The value for 0^h in July, 1840, was omitted as affected by two very large disturbances. The following table shows the limiting value of difference from the mean (the monthly mean for the respective hour), also the number of observations in each year subjected to the process.

Limits of rejection by Peirce's criterion.

		Divis.		No.
1840–41	excludes	53		241
1841–42		44		312
1842–43		37		309
1843–44		28		313
1844–45		33		313
	Mean value	39	Sum.	1488

The limiting value derived from nearly 1500 observations is 39 scale divisions and the separate annual values show plainly the effect of the eleven (ten ?) year period, the year 1843–44 being a minimum year. Certain limits in the adoption of a separating value are allowable and upon trial as to the actual number of disturbances separated, the value 33 scale divisions was finally adopted. Any observation differing 33 divisions or more from its respective monthly mean was therefore marked and excluded from the mean. 33 divisions equals 0·0012 parts of the horizontal force and in the value of the absolute scale it amounts to 0·005. At Toronto the limiting value was 14 divisions =0·0012 parts of the horizontal force equal to 0·004 in the absolute scale (vol. III of the Toronto Observations).

Table No. VI, of the full memoir, shows the number of observations and the number of the larger disturbances, separated by the value 33, as the limits for each month, year, and the whole period.

The total number of observations is 24,231, and of disturbances, 1,698. The limiting value therefore separates one in every 14·3 observations. At Toronto, one in every 12·5 was marked as a disturbance.

The larger disturbances having been excluded, new monthly means were taken, and the process was repeated several times, when required, until all readings differing 33 scale divisions or more had been excluded. Table No. VII, of the full memoir, contains the normals thus found, showing the monthly normals of the bi-hourly and hourly readings of the bifilar magnetometer, reduced to a normal temperature, and corrected for irregularity in the progressive change.

Investigation of the 11 *year (ten?) period, as shown in the changes of the amplitude of the solar diurnal variation of the horizontal force.*

The variation in the amplitude of the diurnal motion of the horizontal force is subject to the same inequality of about eleven years as the declination, and the means of investigation will be analogous to those used in part I. of this discussion. For greater convenience, the preceding monthly normals were united into annual means, and the results put into an analytical form, using Bessel's function applicable to periodical phenomena, and determining the numerical quantities by the application of the method of least squares.

Table No. VIII, of the full memoir, shows the regular solar diurnal variation of the horizontal magnetic force for each year of observation, expressed in scale divisions of the instrument.

These numbers being used in the analytical form, a very close coincidence between the computed and observed results is obtained, the differences, using three terms in the equations, being within the uncertainty of the observed values. The probable error of a single representation for a given hour is ±0·6 scale divisions, or ±0·00009 of the absolute force.

The curves in the accompanying diagram, fig. A, show the results of the corrected means and of the equations. The corrected means are given by dots.

The curves show a double progression in the daily motion, with a principal maximum of horizontal force in the morning, a principal minimum before noon, and a secondary maximum in the afternoon; the precise epochs (to the nearest 5 minutes) and extreme values were computed by means of the preceding formula:

Year.	Principal A.M. max. of horizon. force.		Principal A.M. min. of horizon. force.		Diurnal range in			Secondary P.M. max. of horizon force.		Less than A.M. max. by
July to July.	Epoch.	Amt. Div:	Epoch.	Amt. Div:	Scale Div.	Parts of hor. force.	Value in absolute scale.	Epoch.	Amt. Div:	
	H. M.		H. M.					H. M.		
1840–41	5·45	207·3	11 0	246·1	38·8	0·00142	0·0059	4 05	213·5	6·2
1841–42	5·50	541·7	11 5	565·5	23·8	0 00087	0·0036	3 50	545·1	3·4
1842–43	5·30	779·8	10 55	803·9	24·1	0·00088	0·0037	3 50	784·0	4·2
1843–44	5·40	1001·7	10 50	1016·9	15·2	0·00055	0·0023	4 0	1002·0	0·3
1844–45	5·40	1182·4	10 50	1206·6	24·2	0·00088	0·0037	4 0	1184·8	2·4
Mean,	5·41		10·56				0·0038	3 57		

DISCUSSION OF THE MAGNETIC AND METEOROLOGICAL OBSERVATIONS MADE AT THE GIRARD COLLEGE PHILADELPHIA IN 1840 '41 '42 '43 '44 & '45

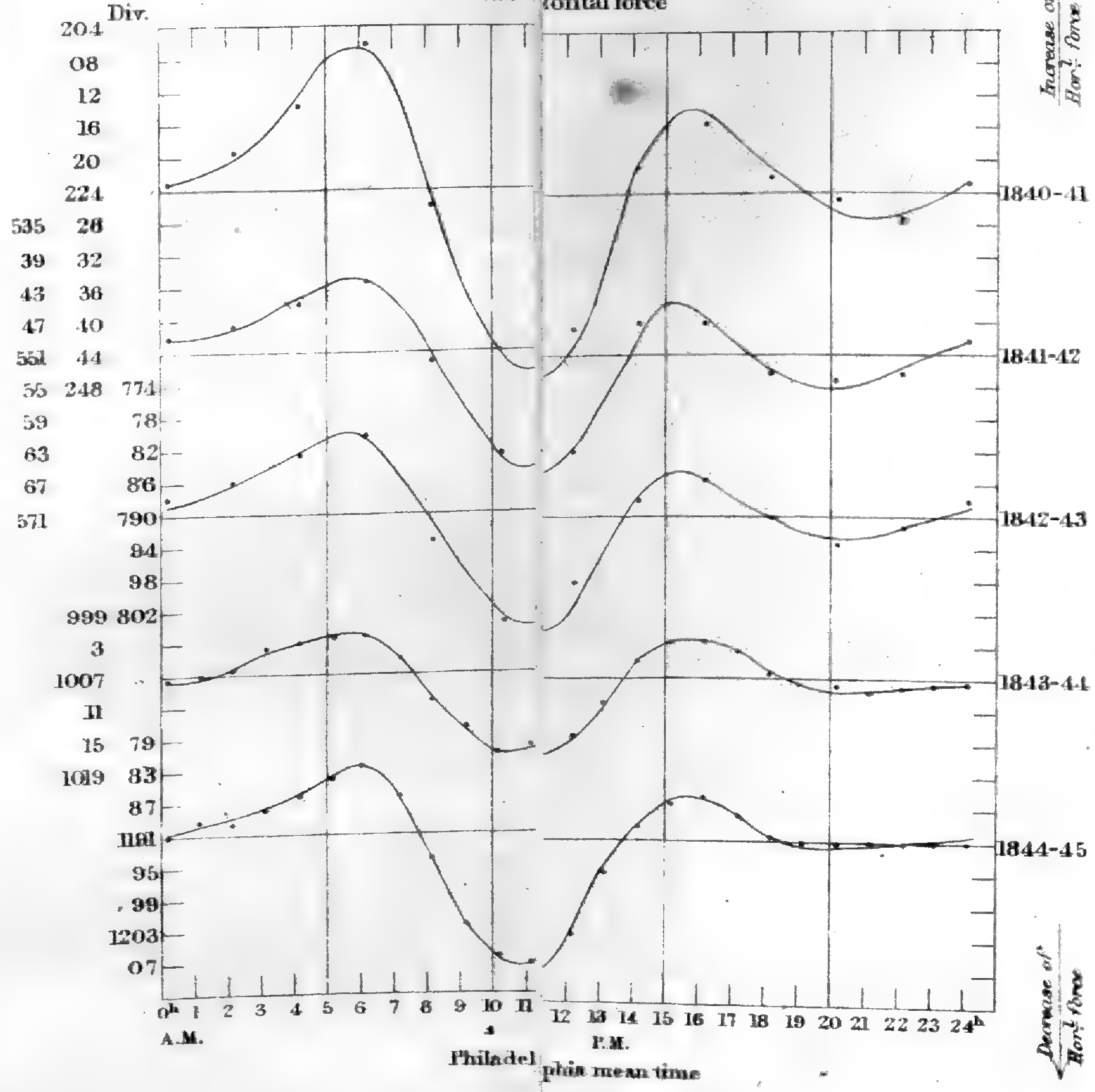
A.D. BACHE L. L.D. SUPERINTENDENT

DIAGRAMS TO PART IV

1862

A

Inequality in the diurnal variation of the Horizontal force

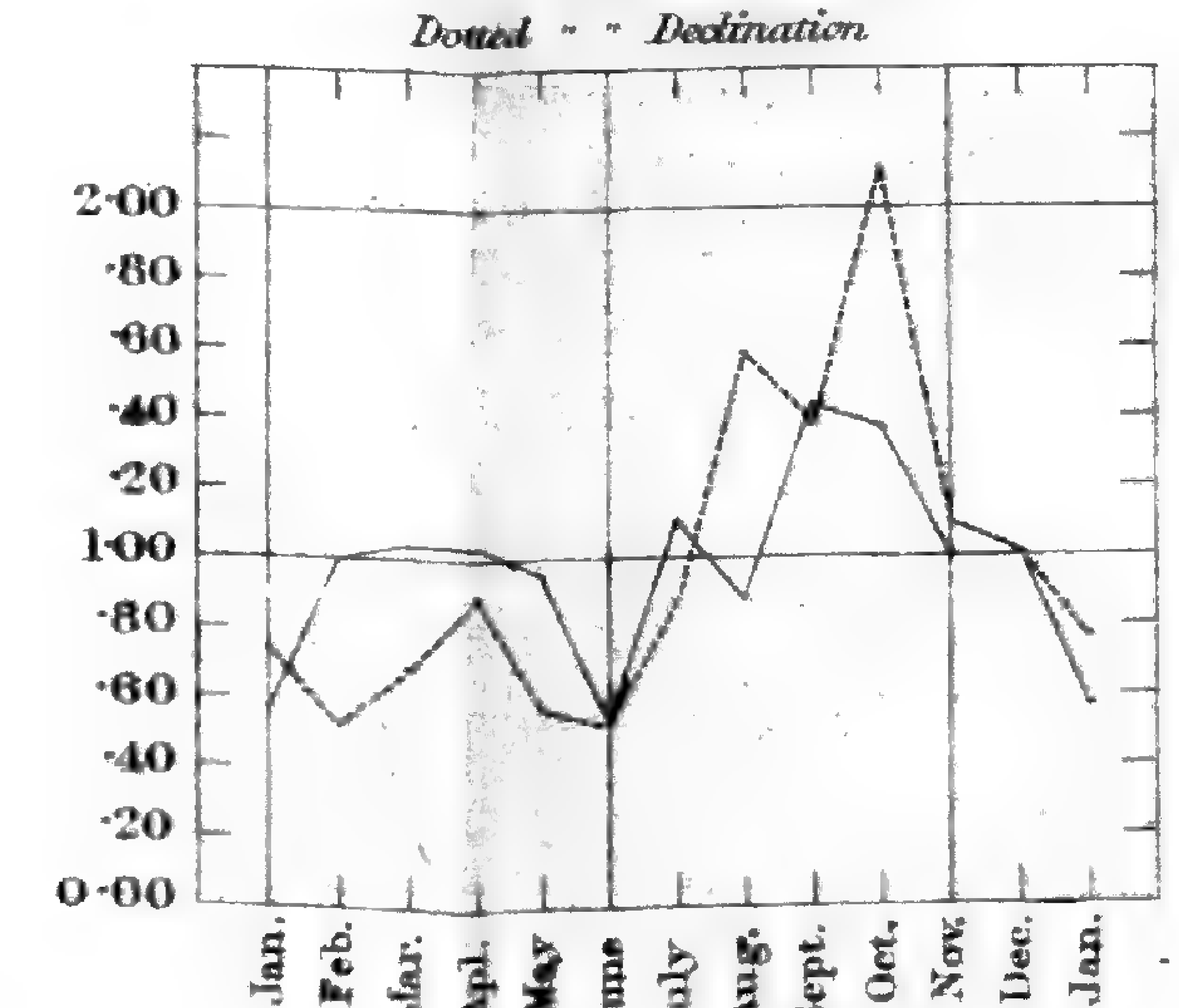


B

Distribution of the number of disturbances in the several months of the year

Full line for Hor.l force

Dotted " " Declination



The secondary minimum is reached about $8^h\ 30^m$ P. M., with a comparatively small range.

The mean value of the force is attained about $7^h\ 55^m$ A.M., and again about $1^h\ 55^m$ P. M., with considerable regularity; it is again reached at $6\frac{3}{4}^h$, and at $11\frac{1}{2}$ P. M., though with less regularity.

At Toronto (see vol. II. of the Toronto Observations) the diurnal variation of the horizontal force has a principal maximum at a little after 4 P. M., and a principal minimum at 10 or 11 A. M.; the secondary maximum occurs about 6 A. M. There is, therefore, this specific difference in the diurnal motion at these two stations: in that at Philadelphia the morning maximum is the higher of the two, while at Toronto it is the afternoon maximum. The difference between the two maxima, as shown above, is almost nothing in the maximum year 1843–44, but increases before (and after) this epoch in proportion to the interval.

At Toronto the daily range seems to be slightly greater. The secondary minimum at Toronto occurs about 2 or 3 A. M., or about 6 hours later than at Philadelphia; this is a second though less significant point of difference.

The minimum daily range occurs in 1843–44, and is then less than one half of what it was in 1840–41.

The equation for the diurnal range in scale divisions gives the following results:

$$R=+19\cdot68-3\cdot78\ (t-1843)+2\cdot77\ (t-1843)^2$$

it represents the observed values as follows:

	Observed R.	Computed R.
January, 1841.	38·8	38·3
" 1842.	23·8	26·2
" 1843.	24·1	19·7
" 1844.	15·2	18·7
" 1845.	24·2	23·2

The minimum range, as given by the formula, is in September, 1843. In part I of the discussion we found the minimum range of the declination in May, 1843, and the minimum from the disturbances of the declination in August, 1843.

Investigation of the eleven (ten?) year inequality in the disturbances of the horizontal magnetic force.

In table VI the number of disturbances in each month has been given as found from the observations; these numbers are however not directly comparable with one another, first on account of some omissions in the record, and secondly on account of the change from a bi-hourly to an hourly series. For any incomplete month the number of disturbances for the whole month is obtained by simple proportion from the number during the part of the month recorded; for January, 1841, the total number becomes 35, for June, 1841, the total number is 18. For 1843, January, February and March, the mean total number of disturbances as found in the same months in the preceding and following year was substituted, this mean gave 8, 20, and 20 respectively; the number of disturbances after October, 1843 were halved to make them comparable with the bi-hourly series. There were two anomalous months, July and December, 1840, in which the disturbances amount to 165 and 120 with an annual mean of 64, whereas in the same months in the following year they amount to only 26, and 26 respectively, with an annual mean of 27. The mean annual difference 37 was applied to the numbers found in 1841, which gives 63, and 63 as a substitute for the anomalous values in July and December, 1840. The anomaly does not exist in the phenomenon itself, but is unquestionably due to the irregularity in the progressive change.

Table No. IX, contains the number of disturbances as distributed over the several years and months; all referred to a uniform series of bi-hourly observations. To this table the monthly means and their ratio, when compared with the annual mean, have been added; also, for comparison, the corresponding ratios found in part I. of the discussion of the disturbances of the declination.

MONTH.	1840 1841	1841 1842	1842 1843	1843 1844	1844 1845	Mean.	Hor. force ratio.	Decl. ratio.
July.	(63)	26	24	15	0	26	1·09	0·86
August.	73	17	3	11	2	21	0·89	1·59
September.	54	41	44	16	13	34	1·43*	1·36
October.	68	28	53	2	16	33	1·39	2·12*
November.	49	32	15	0	21	24	1·00	1·08
December.	(63)	26	5	0	23	23	0·97	1.00
January.	35	14	8	1	13	14	0·59	0·77
February.	50	37	20	3	9	24	1·00	0·52
March.	61	25	20	14	2	25	1·06	0·68
April.	48	38	14	8	16	25	1·06	0·91
May.	46	30	25	2	10	23	0·97	0·58
June.	18	16	4	0	28	13	0·55*	0·53
Sums.	628	330	235	72	153	285	12·00	12·00
Mean.	52	28	20	6	13	24		

In the columns of ratios the principal maxima and minima are indicated by an asterisk.

The annual means exhibit plainly the eleven year inequality, they have been represented by the formula:

$$N = +14{\cdot}4 - 10{\cdot}2\,(t-1843) + 4{\cdot}8\,(t-1843)^2$$

	Observed N.	Computed N.
January, 1841	52	54
" 1842	28	29
" 1843	20	14
" 1844	6	9
" 1845	13	13

According to the formula, the minimum occurs in January, 1844.

We have next to consider the eleven year inequality in the magnitude of the disturbances of the horizontal force. Table No. X contains the aggregate amount of the disturbances, expressed in scale divisions, and also their mean amount obtained by application of the number of disturbances already given in table VI.

For reasons already explained, the amount of disturbances in July, 1840, equal to 10761 scale divisions, has been diminished in the ratio of 165 : 63. The ratio of each monthly mean to the mean amount of the year is also given, together with a column of corresponding ratios, derived from the disturbances of the declination as made out in part I. of the discussion.

TABLE No. X.—*Aggregate and mean amount of the disturbances of the horizontal force expressed in Scale divisions.*

MONTH.	1840-41	1841-42	1842-43	1843-44	1844-45	Mean amount.	Hor. force ratio.	Decl'n. rat.o.
July,	(4089)	1157	1295	669	0	56	1·10	0·87
August,	4084	755	131	471	142	52	1·03	1·61
September,	3092	3075	2099	660	1228	56	1·11*	1·56
October,	3720	1284	2399	169	1412	49	0·97	2·06*
November,	2390	1991	915	34	2173	54	1·06	1·06
December,	6515	1225	239	0	2283	52	1·03	1·00
January,	1186	601	0	111	1402	49	0·97	0·72
February,	2664	1822	44	200	806	50	0·99	0 54
March,	3112	1176	39	1412	127	49	0·97	0·66
April,	2138	2075	676	861	1604	49	0·97	0·94
May,	2456	1211	1187	131	789	47	0·93	0·56
June,	560	794	164	0	2390	44	0·87*	0·42*
Mean amount,	53·9	52·0	48·6	46·3	46·8	50·6	1.00	1·00

Maxima and minima in the columns of ratios are marked with an asterisk.

The inequality in the mean amount of the horizontal force disturbances in each year, indicates the year 1843–44 as the minimum year.

From the preceding results, we may assume the month of November, 1843, as the epoch for the minimum of the eleven (ten year ?) inequality, as far as indicated by the differential observations of the horizontal force.

Further Analysis of the Disturbances of the Horizontal Force.

The distribution of the disturbances in number and mean amount over the several months of the year has been given in tables IX and X.

From table IX we learn that the disturbances are greatest in number in September and March, or April, or about the time of the equinoxes, and least in number about January and June, or about the time of the solstices. At the autumnal equinox the numbers exceed those of the vernal equinox. The same law was found at Toronto. Also, the numbers are smaller at the summer solstice than at the winter solstice, in perfect accordance with the result found at Toronto. These results are shown graphically on the accompanying diagram (fig. B), which contains also the ratio of the disturbances for the declination, in which the same law is apparent.

Table No. X shows that, in reference to the average magnitude of the disturbances, the same law holds good, viz: the greatest relative magnitude occurring about the time of the equinoxes, the greater amount corresponding to the autumnal equinox, and the least to about the time of the solstices, the smaller amount occurring near the summer solstice. The average magnitude of the disturbances of the declination was found subject to the same law.

If we separate the disturbances which increase the force from those which decrease it, we may form the two following tables of the distribution of the disturbances in number and average amount over the several months of the years.

Table No. XI—*Annual inequality in the number of disturbances increasing and decreasing the horizontal force.*

	1840-41		1841-42		1842-43		1843-44		1844-45		Sum.		Ratios.	
	Inc.	Dec	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.	Inc.	Dec	Inc.	Dec.	Inc.	Dec
July,	(38)	(25)	6	20	5	19	1	14	0	0	50	78	1·2	1·0
Aug.	18	55	6	11	2	2	2	9	0	2	27	79	0·7	1·0
Sept.	25	29	5	36	38	6	11	5	9	4	88	80	2·1*	1·1
Oct.	18	50	11	17	37	16	1	1	8	8	75	92	1·8	1·2
Nov.	13	36	1	31	4	11	0	0	0	21	18	99	0·4	1·3*
Dec.	(25)	(38)	8	18	0	5	0	0	15	8	48	69	1·1	0·9
Jan.	19	16	6	8	3	5	0	1	3	10	31	40	0·8	0·6
Feb.	15	35	4	33	2	18	0	3	0	9	21	98	0·5	1·2
Mar.	17	41	10	16	3	17	0	14	1	1	31	92	0·8	1·2
April	18	30	14	24	1	13	1	7	0	16	34	90	0·8	1·2
May,	24	22	16	13	10	15	1	1	5	5	56	56	1·3	0·7
June.	9	9	6	10	1	3	0	0	7	21	23	43	0·5*	0·6*
Sum,	239	389	93	237	105	130	17	55	48	105	502	916	12·0	12·0

In each year the number of disturbances increasing the force is less than the number which decrease it; the numbers of increase are to the numbers of decrease as 1 : 1·8. The numbers of the monthly ratio for the increasing disturbances exhibit the same law as found in table No. IX. With respect to the numbers for the decreasing force, the law is apparently less distinctly marked. The maximum seems to occur about two months later (before the winter solstice) at a time when the number for increasing force is apparently at its minimum. This indistinctness in the law may possibly be due to an irregular distribution in reference to the hours of the day, and would probably disappear in a longer series of observations.

Table No. XII.—*Annual inequality in the mean amount of the distarbances of the horizontal force. Aggregate amount for increasing and decreasing disturbances expressed in Scale divisions.*

Month.	1840–41.		1841–42.		1842–43.		1843–44.		1844–45.		1840–1845.		Av'ge Amt.		Ratios.	
	Inc.	Dec.	Inc.	Dec.	Inc	Dec.	Inc.	Dec	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.
July,	(2202)	(1887)	214	943	292	1003	41	628	0	0	2749	4461	55^{i}	57^{d}	1·2	1·1
Aug.	794	3290	261	494	51	80	69	402	0	142	1175	4408	44	54	1·0	1·0
Sept.	1082	2010	186	2889	1857	242	452	208	873	355	4450	5704	45	56	1·0	1·1
Oct.	726	2994	421	863	1685	714	128	41	691	721	3651	5333	44	53	1·0	1·0
Nov.	520	1870	35	1956	185	730	0	34	0	2173	740	6763	41	56	0·9	1·1
Dec.	2204	4311	289	936	0	239	0	0	1483	800	3976	6286	47	56	1·0	1·1
Jan.	723	463	231	370	0	0	0	111	302	1100	1256	2044	48	50	1·1	0·8
Feb.	649	2015	140	1682	0	44	0	200	0	806	789	4747	42	52	1·0	1·0
March	643	2469	415	761	0	39	0	1412	37	90	1095	4771	39	52	0·9	1·0
April,	732	1406	550	1525	54	622	75	786	41	1563	1452	5902	40	52	1·0	1·0
May,	1000	1456	696	515	412	775	83	48	398	391	2589	3185	42	52	1·0	1·0
June,	307	253	284	510	50	114	0	0	604	1786	1245	2663	44	44	1·0	0·8
Sum,	11,582	24,424	3722	13,444	4586	4602	848	3870	4429	9927	25,167	56,267			12·0	12·0
Number	254	414	93	237	97	92	20	82	96	211	560	1036				
Mean,	46	59	40	57	47	50	42	47	46	47	45	54				

The average amount of a disturbance increasing the horizontal force is 45 scale divisions or 0·0069 in absolute measure; the average amount of a disturbance decreasing the same is 54 scale divisions or 0·0082 in the value of X. The ratio of these numbers is as 1 : 1·2, whereas at Toronto the ratio is 1 : 6·4.

The law of the monthly inequality for amount of increasing or decreasing disturbances is, as in the preceding case, very indistinct and further obscured by the small absolute amount of variation.

In the following table, No. XIII, the larger disturbances have been distributed over the different hours of their occurrence; in this combination the bi-hourly series (of the even hours) of observation has been used throughout.

Hour.	Aggregate amount in scale div'ns	Number of occurrences.	Average amount.	Ratio of numbers.
0 midnight,	8116	142	57	1·12
2	5967	109	55	0·86
4	4961	93	53	0·73*
6	4751*	94	51	0·74
8	5562	104	53	0·83
10	7721*	146	53	1·15
12 noon,	6825	161	42	1·27*
14	6636	127	52	1·00
16	6634	135	49	1·07
18	6894	132	52	1·05
20	7574	139	55	1·09
22	7358	139	53	1·09

Directing our attention to the columns of aggregate amount and of ratios of number of occurrence, we find a principal maximum about 11 A. M., which seems to correspond to the *secondary* maximum of corresponding ratios at Toronto, occurring about three hours earlier; the principal minimum occurs about 5 A. M., which corresponds to the secondary minimum at Toronto, occurring between 5 and 6 A. M.; again at Philadelphia the secondary maximum at midnight is about two hours earlier than the *principal* maximum at Toronto, and the secondary minimum about 4 P. M. corresponds in time to the *principal* minimum at Toronto, occurring between 2 and 6 P. M. Thus the curves at the two stations representing the diurnal variation of the disturbances (irrespective of increase or decrease) of the horizontal force is double crested with an exchange of the principal and secondary maximum and also of the principal and secondary minimum.

In the next table, No. XIV, the diurnal variation of the disturbances is exhibited separately, for disturbances increasing, and disturbances decreasing the horizontal force.

Hour.	Disturb. increasing h. f. Number of occur.	Disturb. increasing h. f. Aggregate amount.	Disturb. increasing h. f. Ratio.	Disturb. decreasing h. f. Number of occur.	Disturb. decreasing h. f. Aggregate amount.	Disturb. decreasing h. f. Ratio.	Excess of aggregate decrease over aggregate increase.
0 midnight,	57	2878	1·28	85	5238	1·21	2360
2	44	2173	0·97	65	3794	0·87	1621
4	42	1998	0·89	51	2963*	0·68	965
6	28	1213*	0·54	66	3538	0·81	2325
8	48	2345	1·04	56	3217	0·74	872
10	61	2732	1·22	85	4989	1·15	2257
12 noon,	74	3134*	1·39	87	3691	0·85	557
14	48	2239	1·00	79	4397	1·01	2158
16	49	2200	0·98	86	4434	1·03	2234
18	45	2005	0·89	87	4889	1·13	2884
20	39	1758	0·78	100	5816*	1·34	4058
22	50	2296	1·02	89	5062	1·18	2766
Sums,	585	26971	12·00	936	52028	12·00	25057

The disturbances increasing and those decreasing the horizontal force evidently follow different laws; at Toronto they were found completely opposed; they are less so at Philadelphia. The principal maximum of increasing disturbances (at noon) seems to be cotemporaneous with a secondary minimum of the decreasing disturbances; again the principal maximum of the decreasing disturbances (at 8 P. M.) corresponds to a secondary minimum of the increasing disturbances. In reference to the main feature, the maximum disturbance of those increasing the force and of those decreasing the force, the Philadelphia ratios show even a greater resemblance to the results at St. Helena and the Cape of Good Hope than to those at Toronto. At the two southern stations, the maximum in the disturbances which increase occurs at 11 A. M., and the maximum in the disturbances which decrease occurs about 6 or 7 P. M. (See vol. II, of the St. Helena Observations.)

Table XIV contains also the hourly excess of the aggregate amount of the disturbances which decrease the horizontal force over those which increase the same. If we divide the numbers by the whole number of days of observation, (nearly 1,500), we obtain the diurnal disturbance variation expressed in scale divisions.

TABLE XV.—*Diurnal disturbance variation.*

	s. d.	In value of absolute scale		s. d.	In value of absolute scale
0h midnight,	1·6	0·00024	12 noon,	0·4	0·00006
2	1·1	17	14	1·4	21
4	0·7	11	16	1·5	23
6	1·6	24	18	2·0	30
8	0·6	09	20	2·8	43
10	1·5	23	22	1·9	29

The average amount by which the disturbances tend to decrease the diurnal variation of the horizontal force is 1·4 scale divisions or 0·00021 in the absolute scale. The maximum effect takes place at 8 P. M., at exactly the same hour when the declination disturbances reach their greatest effect.

In the preceding tables, Nos. XIII, XIV and XV, to the hours indicated, 21½ minutes should be added, the observations being made so much later than the even hours. The preceding discussion shows that for two stations, even at a comparatively short distance, as for Philadelphia and Toronto, there are generally speaking some close coincidences in the laws derived from independent observations; but there are also certain differences in other results; yet it must not be forgotten that for a strict comparability we require, if not simultaneous observations, at least observations extending over similar parts or the whole of an eleven year period. The Philadelphia series includes a minimum year of that inequality with the greater extent of observations before that epoch, whereas at Toronto the series begins after the minimum epoch, and barely extends to a maximum year.

For the purpose of obtaining a better view of the absolute amount of the disturbances and their frequency of occurrence,*

* A table analogous to that given above, showing the distribution of the disturbances in *declination,* is here added for comparison:

Limits adopted. In scale divis.	Limits adopted. In minutes of arc.	Number of disturbances.
8 to 16	3′·6 to 7′·2	1856
16 " 24	7·2 " 10·8	333
24 " 32	10·8 " 14·4	105
32 " 40	14·4 " 18·1	42
40 " 48	18·1 " 21·7	16
48 " 56	21·7 " 25·3	2
56 " 64	25·3 " 29·0	2
64 " 72	29·0 " 32·6	1
beyond		0

they were classified in nine groups of equal differences of 20 scale divisions; the number of disturbances in each was found as follows:

Limits adopted.			Number of disturbances.
In scale divisions.	In parts of hor. force.	In the abso. scale.	
33 to 53	0·0012 to 0·0019	0·005 to 0·008	1159
53 " 73	19 " 27	08 " 11	348
73 " 93	27 " 34	11 " 14	93
93 " 113	34 " 41	14 " 17	45
113 " 133	41 " 48	17 " 20	27
133 " 153	48 " 55	20 " 23	14
153 " 173	55 " 62	23 " 26	4
173 " 193	62 " 70	26 " 29	6
193 " 213	0·0070 " 0·0077	0·029 " 0·032	2
Beyond,			0

The numbers in the last column cannot be considered as entirely independent of the eleven year period, and in attempting to apply the theory of probabilities in reference to the number of disturbances which ought to occur between the assigned limits, it became apparent that the larger disturbances greatly preponderated, a fact no doubt intimately connected with the difficulty in correctly allowing for the progressive change during the first year of observation.

SCIENTIFIC INTELLIGENCE.

I. PHYSICS AND CHEMISTRY.

PHYSICS.—

1. *The Saltness of the Sea:* FORCHHAMMER.—In the course of the last twenty years this distinguished geologist and chemist has executed about two hundred complete analyses of water from all parts of the ocean, but in particular from the Atlantic and the north European seas connected with it. At the eighth meeting of the Scandinavian naturalists, at Copenhagen, in 1860, the important results of these laborious researches were communicated.*

(1.) *Saltness of the Ocean.*—The mean of 140 complete analyses gives 34·304 of salt in one thousand parts of water, unequally distributed over 16 regions. But the specimens being principally taken at lower latitudes, this mean is too high. If we take 34 in one thousand parts as the mean saltness of the sea at the mean atmospheric pressure, and give the results in differences of ten thousandths from this mean, they will become more perspicuous.

Thus the mean saltness of the Atlantic (35.77 thousandth) is expressed by +17.7; of the Californian Pacific +12.2, Japanese Pacific +4.3, Indian Ocean +1.3. These numbers confirm the conclusion of *Lenz* (Pogg.

* Forhandlinger ved de Skandinaviske Naturforskeres VIII Möde, Kjöbenhavn, Juli 1860. Kjöb. 1861, p. 26.
The full detail of the Analyses is: Videnskabernes Selskabs Skrifter, V Række, 1860.

Ann. xx, 73). The Atlantic system of rivers drains by far the greater portion of the continents and has the same position in latitude; thus the evaporation in the Atlantic must be greater than in any other part of the Ocean.

The Atlantic is divided into five regions, viz:

Reg.	III, Arctic region,	mean of 16 analyses,		$+15_6$
"	II, North temperate,	" " 24	"	$+19_5$
"	I, " tropical,	" " 14	"	$+21_7$
"	X, South "	" " 6	"	$+24_7$
"	XI, " temperate,	" " 6	"	$+10_4$
"	XVI, Antarctic Ocean,	" " 1	"	-54_4

Thus the tropical part of the Atlantic is the saltest, and the amount of salt regularly decreases toward the poles; yet the northern Atlantic is more salt than the southern (an influence of the Gulf Stream).*

The first great circulation of terrestrial water is represented in these numbers: only a part of the water evaporated between the tropics directly returns to land and sea in form of rain; another part is carried to the polar regions, here condensed to snow and ice, returning toward the equatorial belt either in great fresh-water currents or in veritable ice-streams, thus re-establishing the equilibrium.

(2.) *Saltness of Oceanic Currents.*—The equatorial current has in the bay of Benin a saltness of $+3_8$; crossing the equator between long. 25° and 35° W., this successively increases by evaporation to $+17_3$ and $+20_8$. On the same longitude, at lat. 15° S. the saltness is $+31_5$, lat. 12–14° N. $+21_9$ and 19_4; thus the current is less salt than the ocean near it—indicating the freshening influence of the great rivers of Guinea. Near St. Thomas, West Indies, the saltness is only $+17$—the enormous amount of fresh water from the Amazon and Orinoco reaching thus far—since a few degrees north of the current the saltness of the ocean is again $+27$. At the Bermuda Islands the saltness is $+18_8$—the evaporation in the Gulf has been counterbalanced by the waters of the Mississippi. Northward the Gulf stream increases to 21_0, 22_6, and 23_6; but at lat. 43° 26′, long. 44° 19′ W. where the St. Lawrence empties, the saltness abruptly sinks to $+1_5$ (a diminution of $2\frac{1}{2}$ thousandths!). From this minimum it slowly rises to $+18_9$ and at last diminishes again in the higher latitudes. *These regular oscillations in the saltness of the great Atlantic current show the fresh water supply obtained from the great African and American rivers, and the effects of evaporation—and make it very probable that these rivers contribute to give the current its particular direction.* Forchhammer represents these numbers by a proportional *breadth* of the current (dotted for negative values)—thus showing at a glance this most important law.

The mean saltness of the polar current of Baffin's Bay is $+8_2$, but increasing towards north,

Latitudes,	58° 53′	64°	69°
Saltness,	$+15_8$	$+10_3$	$+4$

showing how the water of the Arctic sea is freshened by the northern rivers, Greenland glaciers, and the Hudson's Bay rivers.

* The maximum of saltness, $+29$, or 37_{908} thousandths is in the north tropical part of the Atlantic, opposite the dry coasts of Sahara, whence hot, dry winds, but no fresh water may be obtained, lat. 24° 13′ N., long. 23° 11′ W.

The southern polar or *Humboldt's* Current (Region XV) gave +03; it conducts waters from the Antarctic ocean, where −54 (Reg. XVI) has been observed.

(3.) *Counter-currents.*—The Sound, between Zealand and Sweden, exhibits the best investigated example of counter-currents: the surface-current being commonly south *from* the Baltic, the bottom-current always north, *into* the Baltic. According to observations made from April to Sept. 1846, the direction and saltness of these currents were in thousandths:

		To the Baltic.	From the Baltic.	No Current.
Surface,	days, - - -	24	86	24
	saltness, - - -	15994	13342	11801
Bottom, - - - -		19002		

and mean saltness of Reg. VII, the Baltic, 4807, of VI, Cattegat and Sound 15126 and North Sea (Reg. V) 32806 thousandths.

Thus the bottom current contains constantly by far the greatest amount of salt, even in winter, when its temperature is 2–3° F. higher (waters of the Atlantic) than the surface current, partaking of the winter temperature of the Baltic sea.

The saltness of about 20 points of the ocean has been determined for different depths. A difference of about one thousandth corresponds to the greatest depth observed, lat. 12° 36′, N. long. 25° 35′ W., depth 11,100 feet. The saltest water of the surface here evidently is the hottest.

In Davis Strait and Baffins Bay, no considerable difference of saltness for different depths is observed; but in the adjacent Atlantic the lower water is less salt than the warmer above it; and this same cold and less salt bottom current may be traced along the Atlantic, except where great quantities of fresh water are introduced by European and American rivers: making the lower strata the saltest.

In the Indian and Pacific the lowest water everywhere seems to be the saltest (only 4 observations).

(4.) *Composition of the salts.*—Twenty-five different elements have been observed in the salt of the ocean or in plants and animals of the sea: *O*, *H*, *Cl*, *Br*, I, Fl, *S*, P, *C*, N, Si, Fe, Mn, *Mg*, *Ca*, Sr, Ba, *Na*, *Ka*: Ag, Cu, Pb, Zn, Co, Ni; but only those printed in *Capitals* are predominant. Of these, chlorine, sulphuric acid, lime and magnesia may be determined with great exactitude. Comparing all analyses of *ocean water* (including the North Sea) it is found that the relative proportion of the components is nearly constant, being:

Chlorine 100, sulphuric acid 1191, lime 295, magnesia 1108. Total 1811 (for each 100 of chlorine).

The total is the most constant; yet there are small but constant differences for the different regions of the ocean—differences enlarging with the proximity of land, greatest in gulfs and bays, as may be seen from the following interesting comparison of the composition of the salt from Cronstadt (near St. Petersburgh) through the Baltic to the ocean.

To each 100 of chlorine corresponds:

	Lime.	Sulph. ac.	Total.
Cronstadt Harbor,	748	1497	2078
Gulf of Finland, midst,	561	1331	1835

	Lime.	Sulph. ac.	Total.
Gulf of Finland mouth,	3_{78}	12_{23}	....
Sound (at Copenhagen),	3_{28}	12_{57}	18_{14}
Cattegat, at Anholt Isld.,	3_{10}	12_{09}	
North Sea, 50 miles W. of Jutland,	3_{19}	12_{09}	18_{16}
Ocean, mean,	2_{95}	11_{91}	18_{11}

Thus, the animals extract a great part of the solid matter washed down to the sea by the rain, before it reaches the great ocean. G. H.

2. *Density of Ice.*—Dufour has determined the density of ice by two methods. 1st, by employing a mixture of alcohol and water in which the ice could just float, and then determining by the usual methods the density of this liquid. Every possible care was taken to eliminate the various sources of error which in the best conditions Dufour considered to be equal to 0·002. The ice used was carefully deprived of air by long boiling of the distilled water from which it was frozen. Twenty-two experiments by this method gave a mean density of 0·9175, with a mean error of $\pm 0{\cdot}0007$, the greatest and least errors being $+0{\cdot}002$ and $-0{\cdot}0013$. C. Brunner had previously, by another method, fixed the density of ice at 0·9180. Since the publication of these results (*Comptes Rendus*, L, 1039) Dufour has continued his researches by using a mixture of chloroform and rock oil which does not dissolve any portion of the ice, the temperature being kept from $-\frac{1}{2}°$ to $-8°$ C. The results reduced to 0°, with all needful precautions, gave for the mean of sixteen trials 0·9178, the greatest and least differences being $+0{\cdot}0015$ and $-0{\cdot}0012$, the mean difference being $\pm 0{\cdot}0005$. This result differs only 0·0003 from his former determination and but 0·0002 from that of C. Brunner. The expansion of a volume of water in the moment of freezing is therefore $\frac{9}{100}$, or $\frac{1}{11}$ of the volume of the water at 0° C. The former determinations of this constant are chiefly, Placidus Heinrich, (1807), 0·905; Thomson, 0·940; Berzelius, 0·916; Dumas, 0·950; Osann, 0·927; Plucker and Geissler, 0·920; C. Brunner, 0·918; and Kopp, (1855,) 0·909.—(*Comptes Rendus*, May 19, 1862.)

Chemistry.—

3. *Thallium: a new metal.*—The discovery by Crookes of a new element called *thallium*, was noticed in vol. xxxii, p. 411. Subsequently to his original announcement of this discovery (May, 1861) Mr. Crookes distinguished the true metallic character of this substance, which at first was referred by him to the sulphur group. More recently M. Lamy, a French chemist, without a knowledge of Mr. C.'s prior researches,* made the discovery of its existence (also by the spectroscope) while examining the selenium prepared by Mr. F. Kuhlmann from the deposits in the chambers in which sulphuric acid was made by the combustion of pyrites. From this residuum M. Lamy has succeeded in isolating the new metal which he thus describes:

Properties of Thallium.—Thallium has all the characters of a true metal, and, in most of its physical properties, greatly resembles lead. Not

* Mr. Crookes has communicated his researches in a memoir to the Royal Society of London, June 19, 1862, a transcript of which will soon appear in the Chemical News. We have already called attention to the preoccupation of the name *thallium* by Dr. Owen (this Journal [2] xiii, 420, 1852).—Eds.

quite so white as silver, it possesses a brilliant metallic lustre when freshly cut. It appears yellowish when rubbed against a hard body; but this tint is doubtless due to oxydation, for the metal precipitated by a battery from an aqueous solution, or fused in a current of hydrogen, is white, with a bluish grey tinge, which resembles aluminium.

Thallium is very soft, and very malleable; it can be easily scratched by the nail, and cut with a knife. It marks paper, leaving a yellowish streak. Its density (11·9) is a little higher than that of lead. It fuses at 290° C., and volatilizes at a red heat. Lastly, thallium has a great tendency to crystallize, for the ingots obtained by fusion crackle like tin when they are bent. But the physical property, *par excellence*, of thallium,—that which, according to the beautiful researches of MM. Kirchhoff and Bunsen, characterizes the metallic element,—that which led to its discovery,—is the property which it possesses of communicating to the pale gas-flame a green color of great richness, and to the spectrum of this flame a single green ray as distinct and as sharply defined as the yellow ray of sodium, or the red ray of lithium. On the micrometric scale of my spectroscope this ray occupies the division 120·5, that of sodium being at 100°. The slightest portion of thallium, or of one of its salts, gives the green line with such brilliancy that it seems white. The fifty-millionth part of a gramme can, according to my calculations, be recognized in a compound.

Thallium tarnishes rapidly in the air, becoming covered with a thin pellicle of oxyd, which preserves the rest of the metal from alteration. This oxyd is soluble, is decidedly alkaline, and has a taste and smell similar to potash. By this characteristic, as well as by its optical properties, thallium approaches the alkaline metals.

Thallium is attacked by chlorine, slowly at the ordinary temperature, rapidly at a temperature above 200° C. The metal then melts, becomes incandescent under the action of the gas, and gives rise to a yellowish liquid, which solidifies on cooling to a mass of a little paler color.

Iodine, bromine, sulphur, and phosphorus can also combine with thallium, forming iodids, bromids, sulphids, and phosphids.

Recently-prepared thallium preserves its metallic lustre in water. It does not appear to decompose this liquid at the temperature of ebullition, but, by the aid of an acid, it separates its elements, disengaging hydrogen.

Sulphuric and nitric acids are those which attack thallium easiest, especially by the aid of heat. Hydrochloric acid even boiling dissolves it with difficulty. Under these circumstances, there form white soluble salts, sulphate, and nitrate, crystallizing readily, and a slightly soluble chlorid, but capable also of crystallizing.

Natural State and Extraction.—Thallium cannot be considered as very rare in nature. It exists, indeed, in many kinds of pyrites, which are used at the present time in large quantities, principally for the manufacture of sulphuric acid. I may especially mention Belgian pyrites from Theux, Namur, and Philippeville. I have also found it in mineralogical specimens from Nantes and Bolivia, in S. America. * * * *

As to the metal itself, it may be reduced from one of its saline combinations either by the decomposing action of an electric current, or by precipitation with zinc, or by reduction with charcoal at a high temperature. The chlorine may also be separated from its chlorids by potassium or sodium, under the influence of heat; in this latter case the reaction is very energetic.

The small ingot, weighing fourteen grammes, which I had the honor of exhibiting to the Academy, was entirely isolated by a battery of a few Bunsen elements, first from the chlorids originally obtained, and then from the crystallized sulphate formed directly by the solution of this thallium in pure sulphuric acid. * *

In a subsequent communication I will endeavor to fill up some of the gaps at present wanting in its history.—*Chemical News*, July 19, 1862.

TECHNICAL CHEMISTRY.—

4. *Regenerative Gas Furnace.*—Mr. SIEMENS of London has contrived what he calls a regenerative gas furnace adapted to glass houses, iron puddling, and all kinds of furnaces, where long continued high heats are required. We copy Prof. Faraday's notice of this invention as communicated to the Royal Institution of Great Britain, June 20, 1862.

"The subject of the evening was gas glass-furnaces; and having arisen almost extemporaneously, it resolved itself chiefly into an account of the manner in which Mr. Siemens has largely and practically applied gas, combined with the use of his heat-regenerator, to the ignition of all kinds of great furnaces. Gas has been used to supply heat, even upon a very large scale, in some of the iron-blast-furnaces; and heat which has done work once has been carried back in part to the place from whence it came to repeat its service; but Mr. Siemens has combined these two points, and successfully applied them in a great variety of cases—as the potter's kiln, the enameller's furnace, the zinc-distilling furnace, the tube-welding furnace, the metal-melting furnace, the iron-puddling furnace, and the glass-furnace either for covered or open pots—so as to obtain the highest heat required over any extent of space, with great facility of management, and with great economy (one-half) of fuel. The glass-furnace described had an area of 28 feet long and 14 feet wide, and contained eight open pots, each holding near two tons of material.

The gaseous fuel is obtained by the mutual action, at a moderate red heat, of coal, air, and water. A brick chamber, perhaps 6 feet by 12, and about 10 feet high, has one of its end-walls converted into a fire-grate; *i. e.* about halfway down it is a solid plate, and for the rest of the distance consists of strong horizontal plate-bars where air enters, the whole being at an inclination such as that which the side of a heap of coals would naturally take. Coals are poured, through openings above, upon this combination of wall and grate, and being fired at the under surface, they burn at the place where the air enters; but as the layer of coal is from 2 to 3 feet thick, various operations go on in those parts of the fuel which cannot burn for want of air. Thus the upper and cooler part of the coal produces a larger body of hydrocarbons; the cinders or coke which are not volatilized approach, in descending, towards the grate; that part which is nearest the grate burns with the entering air into carbonic acid, and the heat evolved ignites the mass above it; the carbonic acid, passing slowly through the ignited carbon, becomes converted into carbonic oxyd, and mingles in the upper part of the chamber (or gas-producer) with the former hydrocarbons. The water, which is purposely introduced at the bottom of the arrangement, is first vaporized by the heat, and then decomposed by the ignited fuel and rearranged as hydrogen (qu. also carburetted hydrogen, CH_2?) and carbonic oxyd; and only the ashes of the coal are removed as solid matter from the chamber at the bottom of the fire-bars.

These mixed gases form the gaseous fuel. The nitrogen which entered with the air at the grate is mingled with them, constituting about a third of the whole volume. The gas rises up a large vertical tube for 12 or 15 feet, after which it proceeds horizontally for any required distance, and then descends to the heat-regenerator, through which it passes before it enters the furnaces. A regenerator is a chamber packed with fire-bricks, separated so as to allow of the free passage of air or gas between them. There are four placed under a furnace. The gas ascends through one of these chambers, whilst air ascends through the neighboring chamber, and both are conducted through passage outlets at one end of the furnace, where mingling they burn, producing the heat due to their chemical action. Passing onwards to the other end of the furnace, they (*i. e.* the combined gases) find precisely similar outlets down which they pass; and traversing the two remaining regenerators from above downwards, heat them intensely, especially the upper part, and so travel on in their cooled state to the shaft or chimney. Now the passages between the four regenerators and the gas and air are supplied with valves and deflecting-plates, some of which are like four-way cocks in their action; so that by the use of a lever these regenerators and air-ways, which were carrying off the expanded fuel, can in a moment be used for conducting air and gas into the furnace; and those which just before had served to carry air and gas into the furnace, now take the burnt fuel away to the stack. It is to be observed that the intensely-heated flame which leaves the furnace for the stack always proceeds downwards through the regenerators; so that the upper part of them is most intensely ignited, keeping back, as it does, the intense heat; and so effectual are they in this action, that the gas which enters the stack to be cast into the air is not usually above 300° F. of heat. On the other hand, the entering gas and air always pass upwards through the regenerator; so that they attain a temperature equal to white heat before they meet in the furnace, and there add to the carried heat that due to their mutual chemical action. It is considered that, when the furnace is in full order, the heat carried forward to be evolved by the chemical action of combustion is about 4000°, whilst that carried back by the regenerators is about 3000°, making an intensity of power which, unless moderated on purpose, would fuse furnace and all exposed to its action.

Thus the regenerators are alternately heated and cooled by the outgoing and entering gas and air; and the time for the alternation is from half an hour to an hour, as observation may indicate. The motive power on the gas is of two kinds—a slight excess of pressure within is kept up from the gas-producer to the bottom of the regenerator to prevent air entering and mingling with the fuel before it is burnt; but from the furnace, downwards through the regenerators, the advance of the heated medium is governed mainly by the draught in the tall stack, or chimney.

Great facility is afforded in the management of these furnaces. If, whilst glass is in the course of manufacture, an intense heat is required, an abundant supply of gas and air is given; when the glass is made, and the condition has to be reduced to working-temperature, the quantity of fuel and air is reduced. If the combustion in the furnace is required to be gradual from end to end, the inlets of air and gas are placed more or less apart the one from the other. The gas is lighter than the air; and if a rapid evolution of heat is required, as in a short puddling-furnace, the mouth of the gas inlet is placed below that of the air inlet; if the reverse is required, as in the long tube-welding furnace, the contrary arrangement is used. Sometimes, as in the enameller's furnace, which is a long muffle, it is requisite that the heat be greater at the door end of the muffle and furnace, because the goods, being put in and taken out at the same end, those which enter last and are withdrawn first, remain of course, for a shorter time in the heat at that end; and though the fuel and air enters first at one end and then at the other alternately, still the necessary difference of temperature is preserved by the adjustment of the apertures at those ends.

Not merely can the supply of gas and air to the furnace be governed by valves in the passages, but the very manufacture of the gas fuel itself can be diminished, or even stopped, by cutting off the supply of air to the grate of the gas-producer; and this is important, inasmuch as there is no gasometer to receive and preserve the aëriform fuel, for it proceeds at once to the furnaces.

Some of the furnaces have their contents open to the fuel and combustion, as in the puddling and metal-melting arrangements; others are enclosed, as in the muffle furnaces and the flint-glass-furnaces. Because of the great cleanliness of the fuel, some of the glass-furnaces, which before had closed pots, now have them open, with great advantage to the working, and no detriment to the color.

The economy in the fuel is esteemed practically as one-half, even when the same kind of coal is used either directly for the furnace or for the gas-producer; but as in the latter case the most worthless kind can be employed, such as slack, &c., which can be converted into a clean gaseous fuel at a distance from the place of the furnace, so many advantages seem to present themselves in this part of the arrangement.

It will be seen that the system depends, in a great measure, upon the intermediate production of carbonic oxyd from coal, instead of the direct production of carbonic acid. Now carbonic oxyd is poisonous, and, indeed, both these gases are very deleterious. Carbonic acid must at last go into the atmosphere; but the carbonic oxyd ceases to exist at the furnace, its time is short, and whilst existing it is confined on its way from the gas-producer to the furnace, where it becomes carbonic acid. No signs of harm from it have occurred, although its application has been made in thirty furnaces or more.

The following are some numbers that were used to convey general impressions to the audience. Carbon, burnt perfectly into carbonic acid in a gas-producer, would evolve about 4000° of heat, but if burnt into carbonic oxyd it would evolve only 1200°. The carbonic oxyd, in its fuel form, carries on with it the 2800° in chemical force, which it evolves when burning in the real furnace with a sufficient supply of air. The remaining 1200° are employed in the gas-producer in distilling hydrocarbons, decomposing water, &c. The whole mixed gaseous fuel can evolve about 4000° in the furnace, to which the regenerator can return about 3000° more."—*Phil. Mag.*, Aug., 1862.

[The readers of this Journal will remember my description of the furnaces of Moses Thompson for the combustion of wet fuel, (this Journal, [2], xxx, 243). The chemical reactions and many essential points of construction in the two cases are quite identical—the slow combustion of the wet fuel in an anterior furnace very imperfectly supplied with air—the reaction of the vapor of water with the carbonaceous gases in the mixing chamber—the intense heat therein produced by these reactions—the low temperature of the smoke stack are all features of similarity, while the alternate use of the combustion chambers supplied a species of *regenerator*, in fact, if not in name. If Mr. Siemens has not seen Mr. Thompson's plans and specifications, or my description above referred to, he will find in them another proof of the old adage that "there is nothing wholly new under the sun."—B. S., JR.]

II. GEOLOGY.

1. *Dyas, oder die Zechstein Formation und das Rothliegende;* by Dr. HANNS BRUNO GEINITZ, Leipzig. 13 pp. 4to, and 23 plates. Leipzig, 1861. (Second notice).—In the former mention of this work (vol. xxxiii, p. 425) some of the objections were stated to the substitution of the term *Dyas* for *Permian* in geology, and a further notice of the contents of the volume was promised in a future number. We have not yet received the promised review, but the great value of the work and its special interest to American geological science on account of its bearing on the question of the existence of American Permian rocks, leads us to give without delay an abstract of its contents kindly prepared by Mr. A. Schott. The citations are such as bear directly on the question as to whether the Permian is Palæozoic or Mesozoic in its relations—the former being the view now generally held by geologists and sustained by Dr. Geinitz. The work is illustrated by many plates admirable in lithography as well as in accuracy of drawing.

Since 1848 the zoological species of the Permian or "Dyas" have been increased to thrice the original number. This recent work by Dr. Geinitz contains descriptions of 216, some of which are new. All the species hitherto described and known to the author are included.

After extensive study, and a close scrutiny of the fossils, Dr. Geinitz states that the principal leading forms of the formation (the Zechstein) belong to types that are especially characteristic of the Palæozoic era, although some older types, as for instance Trilobites, had disappeared during the preceding Carboniferous period.

The tribe of Saurians, the Russian species excluded, are represented by 9 or 10 species, among which are Lacertians and Labyrinthodonts; the latter appear for the first time during the Carboniferous age and reach their highest development during the Trias.

Of Fishes, 43 species are described, among which *heterocercal* ganoids prevail, and no *homocercal* species occurs. The smooth-scaly species of *Palæoniscus* of the "Rothliegende" and *Acanthoides gracilis* here prove the relationship of the formation with the Carboniferous.

Out of 25 species of Crustacea, besides Entomostraca, which are well known to increase through the earlier formations, there are the more highly organized Tetradecapods and Decapods, the former of which seem to have taken the place of Trilobites. The Tetradecapod described and figured is the *Prosoponiscus problematicus* first described by Schlotheim. It has been recently shown by C. Spence Bate to be an Amphipod. One species is referred to the Brachyurans. It is the *Hemitrochiscus paradoxus* of Schauroth. Dr. Geinitz considers it as related to species of the Pinnotheres family.

Only three species of Annelids have yet been observed.

The species of Cephalopods in the Zechstein are three in number. They do not assist in determining the relations of the Permian period; but there are three species of Pteropods which again point to the Palæozoic era.

Among 25 species of Gasteropods and 50 of Conchifers there are both Palæozoic and Mesozoic forms; of the former *Straparollus* and *Murchisonia*, and of the latter *Schizodus* and *Pleurophorus* have not been observed beyond the Zechstein.

Of Brachiopods, of which 30 species are distinguished, all the leading forms characterizing the Zechstein offer the most indisputable proof of its Palæozoic relations. Some of the genera, as *Productus* and *Strophalosia*, by their immense numbers of individuals performed the same part in this period as Conchifers during the Mesozoic era. Besides these two genera, *Orthis* and *Camarophoria* belong exclusively to the Palæozoic, while *Terebratula* and *Spirifer* occur in later beds. But the very common *Terebratula elongata* of the Zechstein approaches a Devonian form. Moreover, the closest relationship exists between *Camarophoria Schlotheimi* of the Zechstein and *Camarophoria Crumena* of the Carboniferous; between *Spirifer Clannyanus* of the Zechstein and *Spirifer Urii* of the Carboniferous; between *Spirifer cristatus* of the Zechstein and *Spirifer octoplicatus* of the Carboniferous; and between *Lingula Credneri* of the Zechstein and a Lingula of the Coal-measures of Ryhope near Sunderland. These various equivalent forms so closely approach each other, that Davidson and Kirkby pronounced them identical.*

Among the Radiates, *Cyathocrinus ramosus* belongs to a genus only known as belonging to older formations; *Eocidaris Keyserlingi* stands nearest to the Palæozoic genus *Archæocidaris;* a third species, a six-rayed Asterias, is not yet sufficiently known to permit of any conclusion.

Thirteen corals, all related to *Fenestella,* a genus prevalent in the Zechstein, with other species of *Stenopora*, all point to the Palæozoic era. There are 12 species of Foraminifera and 7 of Amorphozoa in the beds. Our knowledge of these tribes in the Zechstein is yet very limited.

We come now to the pages on the Plants of the Permian. The general aspect of the Flora is beyond question Carboniferous and not

* See Kirkby on the occurrence of Lingula Credneri in the Coal-measures of Durham. Quar. Journ. Geol. Soc. London, 1860, xvi, p. 412 and f. Dr. Geinitz dissents from some of the views here proposed.

Mesozoic. Some species of the Coal-measures reach into the "Rothliegende," as for instance *Cyatheites arborescens, Walchia piniformis* and some *Næggerrathiæ;* while other leading plants of the Rothliegende, as *Annularia carinata, Calamites infractus* and others have their nearest relations in the Carboniferous *Annularia longifolia, Calamites approximatus*, etc. The Flora of the Rothliegende very closely approaches that of the Coal-measures, although along with the characteristic Palæozoic genera, there are some others that have their largest expansion in the Mesozoic. The Dyas or Permian is hence pronounced to be Palæozoic as well on the ground of its organic remains as its stratigraphical relations.

3. *Preliminary notice of some of the species of Crinoidea known in the Upper Helderberg and Hamilton Groups of New York* (published July, 1862.); by James Hall—from the 15th Report on the Cabinet of Natural History of the State of N. Y. (Senate, No. 116) pp. 115 to 152. These advance sheets from the 15th Regents' Report embrace descriptions of species of the following genera. The new genera are printed in capitals.

Edriocrinus, *Hall*, Cheirocrinus, (*Hall*), Ancyrocrinus (*Hall*), Platycrinus, (*Miller*), Poteriocrinus, (*Miller*), Cyathocrinus, Forbesiocrinus, (*De Koninck*), Rhodocrinus, (*Miller*) [subgenus] Acanthocrinus? (Rœmer), Trematocrinus, (*Hall*), Actinocrinus, (*Miller*), A. = Megistocrinus, (*Owen*), Cacabocrinus, (*Troost*, Catalogue) Dolatocrinus? (*Lyon*), Myrtillocrinus? (*Sandberger*), Haplocrinus, (*Steinberger*), Nucleocrinus, (*Conrad*, as emended, Pentremites, Olivanites, (*Troost*), Elæacrinus, (*Rœmer*), **Pentremites**, (*Say*)), Eleutherocrinus, (*Shumard*), Codaster, (*M'Coy*).

4. *Dana's Geology.*—This long expected volume will appear in a few weeks. It will be published by Theo. Bliss & Co., Philadelphia, in an 8vo volume of about 750 pages, beautifully illustrated by about 1000 wood cuts, drawn chiefly from American examples or the author's own experience. It will be looked for we know with pleasure, not more for its own sake, than as an evidence of the returning health of its author.

S.

5. *The Student's Manual of Geology;* by J. Beete Jukes, M.A., F.R.S.E., Local director of the Geological Survey of Ireland, &c. A new edition, partially recast and supplied with lists and figures of characteristic fossils. Edinburgh: Adam & Chas. Black. 1862. 12mo, pp. 760.

The new edition of this standard work has just reached us. It is specially rich in facts drawn from Great Britain, but will be read by geologists generally with interest.

III. BOTANY AND ZOOLOGY.

1. *Antherology.*—"*Note on the Structure of the Anther,*" is the title of a short paper read by Prof. Oliver of King's College, London, before the Linnæan Society last November, and printed in the 23d volume of its Transactions. No doubt much remains to be done regarding the structure and homology of the anther. The current hypothesis, as to how the several parts of a stamen are homologous with a leaf, is indeed rather that which "may reasonably be supposed" to be true, or which

may serve to give a clear conception of the probable relation, than that which can be said to be conclusively made out. The present paper, upon the strength of an interesting monstrosity in the flowers of a *Geranium*, controverts the current view in some respects, mainly in that point which identifies the line of the dehiscence of the anther cell with the margin of the blade of the leaf. As to this, it is obvious enough that the lines of dehiscence in the outermost and less complete anthers of *Nymphæa* are really not continuous with the margins of the petal-like filament, and also that the cells appear to belong to the upper stratum of the stamineal leaf. Yet we are not clear that the current hypothesis, liberally interpreted, need be discarded, although it needs modification. That the anther answers to the blade of a leaf, and the pollen to parenchyma, specially developed, Prof. Oliver equally holds; but his conception of the homology of the bilocellate anther-cells is not explicit, at least, we do not well apprehend it. So good an observer as he is will hardly be content until he shall be able to offer a clearer as well as completer exposition.

Upon Mohl's authority, the ordinary received view is credited to Cassini. But Brown's Rafflesia-paper is a year earlier than Cassini's article referred to; and we suppose that Brown would have claimed that his paragraph on the type of the anther, on p. 211, with the appended footnote, expresses or implies nearly the whole. And Rœper, who soon after developed the hypothesis nearly as now received, refers to Brown, but not to Cassini. It is true that Brown, in his notion that pollen was produced, like ovula, "on the margins of the modified leaf," was quite astray. But it is curious that Prof. Oliver, who quotes this remark, seems not to have noticed that it, in connection with the context, by implication must assign to Brown the paternity of the current hypothesis, at least as respects the point which is here controverted. And this hypothesis accords so well with nine anthers out of ten, and those the most normal, that, with Mohl, we are not yet inclined to abandon it. "That the septa of 'untransformed tissue' may be regarded morphologically as resulting, in part from the inflected epidermis of the adjacent anther-cells," would be readily conformable with Brown's view, as we judge from his language; and the fact that the septum frequently shows signs of being bilamellar, might also be adduced. But, on the other hand, its organic connection with the connective, or with the dorsal part of the cell, and not with the line of dehiscence, is too obvious to be overlooked.

Holding, still more strictly than does Prof. Oliver, the notion that the anther *is* the body or lamina of the stamineal leaf, we must agree with him in his estimate of the peculiar theory of Mr. Bentham, broached several years ago, and recently explained and defended, (in Jour. Linn. Soc. 6, p. 118, 122), viz., that anthers are homologous with petiolar glands, the lamina in stamens being either wholly absent, or represented by a petaloid appendage of the connective, of which we suppose that of most *Compositæ* and in *Asclepias* would be good examples. Viewed morphologically or physiologically, this seems to us equally a retrograde step. But if we did receive this hypothesis, we should be led thereby to believe (which now we do not) that a petal with a stamen before it might sometimes be homologous to a single leaf.

In his important "*Notes on Malvaceæ and Sterculiaceæ*—the article above referred to—among other matters of high consideration, Mr. Bentham works out his hypothesis of glandular stamens with some detail, in explanation of the andrœcium of certain *Sterculiaceæ*. We are not prepared to discuss the points here involved, not only because this would require time and space which we cannot now afford, but also more knowledge than we can now pretend to. But we would remark:—

(1.) That we are well satisfied in finding that Mr. Bentham fully accepts the view that a single leaf of the *andrœcium* may be represented by a phalanx of stamens (this, indeed, he had previously favored), or by a cluster of stamens and a scale or petaloid body, such for instance as we have in an American *Tilia;* also "that a *dédoublement* of the petal may produce the inner petaloid scale of some *Sapindaceæ*, *Violaceæ*, *Bixaceæ*, &c., or the fimbriate scales in the tube of *Cuscuta* and other gamopetalous flowers." That is about as far as we incline to go in this direction. But, as Mr. Bentham homologizes these scales or appendages with petiolar glands on the one hand and with anthers on the other, he ought not greatly to object when some convert to his theory imagines such potential anthers to become actual ones.

(2.) But Mr. Bentham's ingenious hypothesis to account for the anteposition of the outermost stamens to the petals in *Sterculiaceæ*, &c., as deduced from *Glossostemon*, apparently would work just as well on the supposition that the anthers answer to the leaflets of a palmately compound leaf, the middle one sterile. And

(3.) *Sidalcea*, that most instructive Malvaceous genus, and a pentandrous *Parvonia* on the one hand, and the American section of *Tilia* on the other, taken together, offer to our view most serious if not conclusive objections to the conjecture that, in the family in question, the real or the primary verticil of stamens does in fact alternate with the petals, and is indicated by the teeth or stamniodia, these representing the axes or apices of so many leaves which, revolute in æstivation, are laterally antheriferous. Nor do we see how this view applies to *Melochia* and its allies, where only a single stamen stands before each petal, unless these stamens are conceived to be double, as is supposed of *Fremontia*.

(4.) Apropos to the latter, and much inclined to accept Mr. Bentham's views in regard to the andrœcium of *Bombaceæ*, we remark that the position of the stamens when reduced to a single verticil, as in *Fremontia*, *Cheirostemon*, and *Eriodendron*, is before the sepals, instead of being before the petals as may be deduced to be the case in the true *Malvaceæ* no less than in *Sterculiaceæ* and in *Tilia*. Whatever hypothesis be adopted in explanation, the position of the stamens relative to adjacent parts of the flower is important. On this and other accounts, in the annexation of the *Bombaceæ* to *Malvaceæ*, we could not hesitate to accord to the group the rank of a suborder. A. G.

2. *Wood-cells of Hamamelideæ imitate Coniferous markings.*—A paper "*On Sycopsis*," a new Hamamelideous genus, published by Professor Oliver, in the 23d volume of the Linnæan Transactions, brings to view a fact discovered by the late Mr. Griffith, in *Bucklandia*, and announces for all the other genera of this order, that the wood-cells exhibit markings "in all respects quite similar to those of the so-called 'glandular markings' of coniferous wood." As Prof. Oliver hints at an affinity to or pos-

sible remote derivation from *Coniferæ* being indicated thereby, it may be interesting to note that Mr. Brown, in the 19th volume of the Linnæan Transactions (p. 231) draws from analogous facts an opposite conclusion, viz.: "That conformity in vascular structure, even when accompanied by peculiarity of tissue, does not always indicate, much less determine, botanical affinity." Which is considerably safer than the genealogical view hinted at by Prof. Oliver. As the wood of *Hamamelideæ* has the usual proportion of vessels, &c., Prof. Oliver intimates, as well he may, that it offers "a higher measure of specialization" than that of Coniferæ, even although the latter has been "designated by a distinguished naturalist as the highest specialized tissue known." Interesting remarks are given upon the geographical distribution of this order. A. G.

3. *Journal of the Proceedings of the Linnæan Society, Botany.* Nos. 22, 23.—Having already drawn upon articles contained in these numbers, we need only enumerate the contents, viz.:

Col. Munro's *Identification of the Grasses of Linnæus's Herbarium* is concluded.

Mr. Bentham contributes *Notes on Caryophylleæ, Portulaceæ and some allied Orders;* also *Notes on Malvaceæ and Sterculiaceæ.* The results of these papers find their place in the new Genera Plantarum of Bentham and Hooker, the first part of which is nearly all printed.

On the Two Forms or Dimorphic Condition in the Species of Primula, and on their remarkable Sexual Relations; by Charles Darwin.—The two forms are identical with those of *Houstonia,* and the like, long ago recognized by our botanists; and those of *Primula* have perhaps been longer known in Europe. That this was a transition towards a separation of the sexes was an early and obvious suggestion; but the fact that both forms seeded freely seemed to negative that supposition. It remained for Mr. Darwin to show, and he has admirably shown, that the object of the arrangement is to secure cross-fertilization between the individuals of the same hermaphrodite species,—an object effectually reached in nature in many different ways, most commonly through the agency of insects; and here is one of the adaptations to this end. The details we may perhaps explain upon some convenient occasion.

West African Tropical Orchids, by Dr. Lindley.

Notes on *Contoubea volubilis, Mart. and some other Gentianæ of Tropical America,* by Dr. Grisebach. The plant in question is a homely, small-flowered, voluble plant of C. Wright's Cuban collection, No. 1372, to which, the name now being vacant, Dr. Grisebach has transferred that of *Gœppertia.* In annotations upon plants of the order, the author remarks of *Erythræa* and four other related genera, that they are mere artificial distinctions. He might have added *Gyrandra* to the list. Another very interesting and striking plant of Wright's collection, No. 1346, is the type of a new genus, namely, *Zonanthus Cubensis.*

On Inocarpus, by Mr. Bentham, the President of the Society. Curiously enough, Forster's genus *Inocarpus,*—a well-known tree of the South Sea Islands, the seeds of which, boiled or roasted, are eaten like chestnuts,—proves in Mr. Bentham's hands to a Cæsalpineous Leguminosa, with a gamopetalous corolla, allied to the South American *Etaballia* and to the little known *Bocoa* of Aublet. A. G.

Address of George Bentham, Esq., President, read at the Anniversary Meeting of the Linnæan Society, May 24, 1862.—A Botanist succeeding to the chair ably filled for several years by a distinguished Zoologist, very naturally and properly takes up his own department for his illustrations when, upon such an occasion, he passes in review the principal works and investigations in natural history recently produced, and when he indicates some of the most promising fields now open to the young naturalist, especially to those who can devote but a portion of their time to science. The survey, as would be expected, is candid and fair, the advice eminently practical, and the particular example which he commends—"the remarkable success which has attended the long-continued, persevering, and well-combined observations of Mr. Darwin," which in detecting "the wonderful contrivances for the cross-fertilization of Orchids," "has revealed to us so much of surprising novelty in the economy of nature"—contrivances "which had hitherto been unsuspected, even by those botanists who had specially devoted themselves to that family—is wonderfully stimulating. "And this," continues the President, "is but a sample of that extraordinary variety of facts collected by him, and brought to bear upon his theories, which must be patent to every impartial reader of his works; whilst all who have had an opportunity of watching his *modus operandi* are well aware that he never brings forward an observation without taking every precaution to ensure its accuracy, thoroughly sifting every circumstance that appears to militate against it. It is indeed to be hoped that, without waiting for the completion of the great work that is to embody the whole series of his *pièces justificatives*, Mr. Darwin will continue to illustrate separate portions of his subject, each one of which is sufficient to give a lasting name to its author. In the meantime, let every lover of nature, who from his residence in the country may have leisure and opportunities of observing, follow in the track thus opened out." . . . Let us adopt for the insects and plants of our islands the nomenclature and classification the most convenient for study, and devote our attention to their economy and development, to the complicated structures disclosed by the microscope, and to those innumerable influences which we term accidental, but which appear all to form part of one general plan for the balance of power in the natural world."

These remarks, from one who is supposed by no means to favor Mr. Darwin's theory of derivation of species, seem to us better considered and more consonant with the scientific spirit of the age, than some others which eminent naturalists have thought it their duty to make. A. G.

4. *Botany of Northeastern Asia.*—The Russian botanists are still active in researches and publications relating to the flora of that portion of the empire (including its newly-acquired territories) which approaches North America—botanically even more than geographically—and which we must regard with peculiar interest. The *Flora Ajanensis*, (1858), and the *Primitiæ Floræ Amurensis*, (1859), are now followed by Dr. Regel's *Tentamen Floræ Ussuriensis*, (1861, pp. 228, imp. 4to, with 12 plates; separately issued from the Memoirs of the Imperial Academy, St. Petersburgh), an account of the plants collected in the district of the Ussuri River, northeast of Corea; and still later by the first part of the Botany of Radde's Journeys in Southeastern Siberia, (*Reisen in den Süden von*

Ost-Sibirien, im Auftrage der Kaiserlichen Russischen Gesellschaft, ausgeführt in den Jahren, 1855–1859, *durch G. Radde*, Bot. Abth. Moscow, 1861, 8vo), by the same indefatigable author. Of the latter we have only the first part, of 211 pages, and five 4to plates. It is a more extensive work than the general title would denote, being a kind of supplement to the Flora Rossica, for all accessions from the wide regions east of the Altai, including Kamtschatka and even Sitcha. Its fullness may be estimated when we state that the 211 pages before us extend only from the *Ranunculaceæ* to the *Cruciferæ* inclusive; and also that, in the form of notes, Dr. Regel gives new and complete revisions (at least for the Russian Empire) of many of the larger or more difficult genera, or their more troublesome sections. *Pulsatilla*, *Adonis*, *Aconitum*, *Corydalis*, *Barbarea*, and a part of *Draba* are thus revised, on the author's own proper observations, and apparently upon excellent principles. Among other things which attract our attention, we note that he replaces the name *Ranunculus Purshii*, Hook., by the earlier *R. radicans*, C. A. Meyer; he should have gone back to the earlier name, (*R. Gmeleni*, DC.); that having a second apetalous *Isopyrum*, he takes up Rafinesque's genus *Enemion;* and that he suspects *Caulophyllum robustum* to be only a geographical variety of *C. thalictroides*. As to this, we had here reached the same conclusion, from such incomplete comparisons as we could make; but additional materials are wanted. To the works abovementioned we may add Dr. Regel's Revision of the Russian and outlying species of *Thalictrum*, a separate publication, pp. 50, 8vo, with three plates. The first plate represents *T. sparsiflorum*, which, Dr. Regel will perceive from the observations in this Journal, under No. 76 of Dr. Parry's collection, is truly a denizen of North America. These publications are all full of matters of immediate interest to us, and suggestive of numerous particular enquiries; and their continuation with the same acuteness and spirit, promises much for the advancement of our knowledge of the vegetation of the northern temperate zone, and of the geographical relations of the species. A. G.

5. *Cork.—De la Production Naturelle et Artificielle du Liége dans le Chêne-Liége*, par M. Casimir de Candolle. (Ext. from the Mém. Soc. Phys. et d'Hist. Nat., Genèv., vol. xvi, 1860), with 3 plates. This paper is interesting as the first botanical publication of the inheritor of this honored name in the third generation of botanists, and as an account of the formation and structure of cork in the Cork-oak, both in the natural state, and especially under the operation which has to be practiced in order to the production of cork of any commercial value. The operation consists in the removal from the trunk of the natural corky layer of the bark down to the subjacent cellular envelope or green layer; which is done in Algeria, (where young De Candolle's observations were made), during the summer or autumn. Shortly after this operation, a new corky stratum begins to form in the green layer, at a variable distance from its denuded surface. This grows by annual layers upon its internal face, just as the original and worthless corky layer did; but this is much finer and much more elastic, and is the commercial article. When this valuable cork has attained sufficient thickness, ordinarily after seven or eight years, it also is removed, with the same result as before, i. e., still another

new corky stratum is formed below; and so successive crops may be taken off the trunk every seventh or eighth year for a long while, or even indefinitely. A. G.

6. *Martius, Flora Brasiliensis*, fasc. xxix, and fasc. xxx; both issued in January, 1862. The first of these contains the remaining tribes, *Dalbergieæ* and *Sophoreæ*, of the Papilionaceous *Leguminosæ*, elaborated by Mr. Bentham, pp. 218–350, tab. 57–127, with Indexes and a title-page,—so that the *Papilionaceæ* of themselves compose a volume. The name of the author warrants the excellence of the elaboration. The plates profusely illustrate the *Dalbergieæ*, and were drawn at Munich. The 30th fasciculus, a comparatively small one, is devoted to the *Scrophularineæ*, elaborated by Prof. J. A. Schmidt, of Heidelberg, to the illustration of which 18 plates are devoted. So this great work makes very good progress. A. G.

7. *Grisebach's Flora of the British West Indian Islands;* Parts iv and v have appeared since our last notice. Although the third part closed with an index, and contained the title-page as of the first volume, we are pleased to find that these are only temporary, that the paging runs on into the new parts, so that the whole will compose only one volume. As part 5 finishes the *Monocotyledons*, and part 6 is already in press, we look for an early completion of this important work. Meanwhile C. Wright's collections in Cuba are invaluable contributions of materials for a Flora of Cuba. In the present volume, and in the forthcoming portion of his memoir upon Wright's Cuban collection, Prof. Grisebach has done much to clear up our knowledge of West Indian *Rubiaceæ*, and to improve or complete the characters of the tribes and subtribes. *Erigeron Bonariensis* of Linnæus we have taken to be something distinct from *Conyza albida.* It should be looked up from original sources. *Chionanthus*, no less than *Linociera*, has albuminous seeds, as long ago noted here. *Dianthera* of Gronovius and Linnæus is rightly taken up. Linnæan genera are not to be superseded by later names. A. G.

8. *On the genus Euphorbia in DeCandolle's Prodromus;* by G. Engelmann.

After an interval of five years a continuation of the Prodromus, constituting a part of the 15th volume, has just made its appearance, containing a monograph of the suborder *Euphorbieæ* by E. Boissier. The celebrated author has in this work described and arranged with admirable care, conscientiousness and lucidity the heretofore almost unapproachable mass of species of one of the most numerous genera of plants spread over the whole globe. He has, with great propriety retained this eminently natural genus as Linnæus constituted it, retaining as subdivisions some of the numerous genera into which former authors from Haworth to Klotzsch and Garcke have sought to divide it.

Mr. Bossier describes 693 species, which for the greatest part he had seen and carefully analyzed himself, and adds 30 others as incompletely known, thus constituting the most numerous genus known, after *Panicum*, of which Steudel enumerates 864 species, and larger than *Senecio* of which DeCandolle knew 601 species. These species are arranged into two great divisions, the *Appendiculatæ*, with *petaloid* appendages to the glands of the involucrum, and the *Exappendiculatæ*, without such appendages. The former, containing 253 species, are for the greater part found in America: the latter, with 440 species, principally inhabit the Old World. This division of the genus is probably the most natural that could be made, though the first five species of the division are called by M. Boissier himself *Gymnadenieæ*, thus referring them properly to the second division, and though other closely allied forms, such as *E. corollata* and *E. Ipecacuanhæ*, had to be widely separated on account of the difference in this particular.

The *Appendiculatæ* are divided into 11 sections, the first and largest of which is *Anisophyllum* with 176 species, the best known representatives of which with us are *E. maculata* and *E. hypericifolia*, here called *E. Preslii.* We have in our flora 36 species of this section; one of these, *E. Preslii*, is spread over the whole of North America; 6 are found in the Mississippi valley or east of it; 3 common in the West Indies, extending into Florida (of these *E. hypercifolia*, L., proper, is not mentioned as a Florida plant by Mr. Boissier) 24 are peculiar to the western plains, Texas, New Mexico and Arizona, and 2 are exclusively Californian. Several of the 24 southwestern species extend farther south into Mexico, and 2 of them, *E. prostrata* and *E. serpens*, which latter extends up the Mississippi and its confluents, are wide spread species found through the warmer parts of the whole globe.

Mr. Boissier has recognized several forms as distinct species in which I have only been able to see so many varities of one polymorphous species. Thus the old *E. hypericifolia* comprises his small-flowered and fruited tropical *E. hypericifolia* proper, our larger-flowered, larger and darker-seeded *E. Preslii*, and several tropical and eastern forms, as the hairy-fruited *E. lasiocarpa*, the large seeded *E. Brasiliensis*, and others. *E. zygophylloides* was very properly separated from *E. petaloidea*, but *E. polyclada* I suspect is only a form of the latter. *E. micromera*, which I had taken for a form of *E. polycarpa*, seems well distinguished. I may add here that the western *E. serpyllifolia*, formerly united by me to several forms of the old world under the name of *E. inæquilatera* and *E. glyptosperma*, have lately been found by Mr. T. J. Hale in Wisconsin, as also *E. Geyeri* first discovered in Illinois, which last seems to preserve its distinction from *E. petaloidea.*

The second section, *Zygophyllidium*, comprises 4 species, of which 3 belong to the southwest and one to Mexico.

The 25 species of the 3d section, *Cyttarospermum*, are all inhabitants of the warmer parts of America, 13 being Mexican, and only one of our species, *E. bifurcata*, perhaps an intermediate link between this and the former section, is doubtfully referred here.

Sections 4 and 5 contain few, only American species, none of them belonging to our flora.

Section 6, *Petaloma*, consists of 3 species, two of which, *E. marginata* and *E. bicolor*, belong to the west and southwest, and the third is a closely allied Mexican form.

Sections 7 and 8 are small and almost entirely South American.

The 9th section, *Tithymalopsis*, on the contrary, is entirely North American, 7 species belonging to our flora and one to Mexico. *E. corollata*, including *E. paniculata*, is the wide-spread and well-known representative of this section. The heretofore imperfectly known Michauxian species, *E. pubentissima* and *E. mercurialina* have been restored by Mr. Boissier, after a careful examination of the original specimens in Richard's herbarium, now in the hands of Mr. Franqueville of Orleans. The former, however, may be a variety of *E. corollata*. Mr. Boissier has from the same source ascertained that *E. polygonifolia* Michx., is a form of *E. Curtisii*, though his other specimens, in the herbarium, of the Jardin des Plantes in Paris, is a form of *E. Ipecacuanhæ.*

Trichosterigma, the 10th section, comprises 5 species, all of them Western Mexican, two of which reach into our boundaries. The 2 species of the 11th section belong to South America.

The second great division, *Exappendiculatæ*, is divided into 16 sections, 2 of which only are represented in the North American Flora.

Sections 12–14 contains few species, none of them belonging to our flora. Section 15, *Poinsettia*, with 11 species, is almost entirely North American, or properly Mexican; 1 or 2 species extending farther south, and 6 reaching into our flora. The best known representative of this section, *E. heterophylla*, has been restored, recognizing *E. cyathophora* and *E. graminifolia* as varieties of the Linnean species. The New Mexican *E. cuphosperma*, which I had described as a form of *edentata*, is here described as a distinct species. *E. eriantha* ought to have been mentioned as also occurring in Arizona. It may be remarked that the name of Arizona does not occur in this or other botanical publications, as a district formerly of the Mexican State of Sonora; just as Louisiana even yet, after 50 years of separate existence, sometimes is used in botanical works for the Upper Missouri country.

Sections 16–25, with 115 species, almost all belong to the Old World; they include the Euphorbiæ with succulent stems, those with the forms of Cacti.

Section 26, *Tithymalus*, comprises the great mass of the Euphorbiæ of the Old World Of the 302 species constituting it we furnish only 23, most of which belong to the southwest; 5 others have been sparingly introduced from Europe into the eastern States.

The sub-section *Ipecacuanhæ* is the only sub-section of *Tithymalus*, whose species, 19 in number, all belong to the New World: 4 of them are peculiar to the Southeast; one comes over from the West Indies to the southern extremity of Florida, and allied, as it appears, to the Chilian forms, is peculiar to Southeastern New Mexico.

Of the sub-section *Galarrhæi* (with obtuse glands), out of 108 species we have only 5 native species, distributed from the Alleghany Mountains to western Texas and California.

The largest sub-section, *Esulæ*, (with two-horned glands). comprising 139 species, counts in our flora 12 species, 2 of them in the middle and southern States, and all the rest belonging to Texas, New Mexico and California.

The 27th section is constituted by a single species, an Australian shrub.

We find the name of two of our published species *E. commutata* Toglm. in Gray's Manual, and *E. Floridana*, Chapm. in his Southern Flora, replaced by *E. Ohiotica*, Steud. & Hochst. and *E. sphærosperma*, Shuttlew., names which have been published only on labels in distributed collections, while *E. Rü͏zeliana* Shuttlew., has not been substituted for *E. Curtisii* though published in the same manner. [We must insist on the restoration of the earlier published names, given without knowing of the distributed ones on tickets.—Eds.]

The following table exhibits the geographical distribution of the 80 species of Euphorbia, credited by M. Boissier to the Flora of the United States. The immense extent of this Flora may be properly divided into five districts.

I. Flora of the Northern and Middle States, or the Flora of Gray's Manual, which however should naturally include the wooded part of Missouri, and exclude Northern Illinois and Wisconsin or the Northwestern Prairie region. I adopt, however, Prof. Gray's limits, adding Missouri.

II. Flora of the Southeastern and Southern States, east of the Mississippi, or the limits of Chapman's Flora.

III. Flora of the Western Prairie Region from the British Possessions to the Rio Grande.

IV. Flora of the Rocky Mountains, including the greater part of Washington and Oregon, the whole of Utah, Colorado, New Mexico and Arizona.

V. Flora of the Pacific slope of the continent.

Some species extend through most of these regions, while others are common to several of them, and others again are limited to a single one; some extend into the extreme limits of our Flora from the southern countries adjacent. The species, therefore, may be divided according to their geographical extension into the following 12 classes:

1. Species common to the greater part of our territory. I class here *Euphorbia Preslii, serpens, serpyllifolia, maculata, corollata, dentata, heterophylla* and *dictyosperma*, though some of them are common only to the eastern, others

more to the southern or western regions, and some extend only to the edges of some of the floral districts: 8 species.

2. Species peculiar to the flora of the Northern and Middle States. I refer here a single species, *E. Geyeri*, somewhat artificially it must be confessed, because it more properly belongs to the northwestern Prairie region; but thus far it has been found nowhere but in northern Illinois and in Wisconsin: 1 species.

3. Species common to Gray's and Chapman's district: 6 species.

4. Species peculiar to the southeastern flora: 8 species.

5. Species common to the southeastern and the western flora: 3 species.

6. West Indian species extending into Florida: 4 species.

7. Species peculiar to the western and southwestern Prairie flora: 19 species.

8. Species common to the last and the following region: 3 species.

9. Species peculiar to the Mountain region of the west and southwest; many of these, as well as of section 7, undoubtedly extend into Mexico: 20 species.

10. Mexican species extending into the last region: 3 species.

11. Species common to the western Mountain region and the flora of the Pacific slope: 2 species.

12. Species peculiar to the Pacific slope: 3 species.

Geographical Distribution of Euphorbiæ within the Flora of the U. States.

	1. Anisophyllum.	2. Zygophyllidium.	3. Cyttarospermum.	6. Petaloma.	9. Tithymalopsis.	10. Trichosterigma	15. Poinsettia.	26. Tithymulus: 4. Ipecacuanhæ.	26. Tithymulus: 9. Galarrhæi.	26. Tithymulus: 10. Esulæ.	Total.
1. Common to whole country,	4	–	–	–	1	–	2	–	1	–	8
2. Peculiarly northern,	1	–	–	–	–	–	–	–	–	–	1
3. Northeast and southwest,	2	–	–	–	–	–	–	1	2	1	6
I. Northeastern Flora.	7	–	–	–	1	–	2	1	3	1	15
1. Common to whole country.	4	–	–	–	1	–	2	–	1	–	8
3. Northeast and southeast,	2	–	–	–	–	–	–	1	2	1	6
4. Peculiarly southeastern,	–	–	–	–	5	–	–	3	–	–	8
5. Southeast and west,	2	–	–	–	–	–	–	–	–	1	3
6. From West Indies,	3	–	–	–	–	–	–	1	–	–	4
II. Southeastern Flora.	11	–	–	–	6	–	2	5	3	2	29
1. Common to whole country,	4	–	–	–	1	–	2	–	1	–	8
5. Southeast and west.	2	–	–	–	–	–	–	–	–	1	3
7. Peculiar to Prairie Flora,	8	1	1	2	1	–	1	–	2	3	19
8. Prairie and Mountain Flora,	3	–	–	–	–	–	–	–	–	–	3
III. Western Prairie Flora.	17	1	1	2	2	–	3	–	3	4	33
1. Common to whole country,	2	–	–	–	–	–	2	–	1	–	5
8. Prairie and Mountain Flora.	3	–	–	–	–	–	–	–	–	–	3
9. Peculiar to Mountain Flora,	9	2	–	–	–	–	3	1	–	5	20
10. From Mexico,	1	–	–	–	–	1	–	–	–	1	3
11. Mountain & Pacific Flora,	2	–	–	–	–	–	–	–	–	–	2
IV. Western Mountain Flora,	17	2	–	–	–	1	5	1	1	6	33
1. Common to whole country,	2	–	–	–	–	–	1	–	1	–	4
11. Mountain & Pacific Flora,	2	–	–	–	–	–	–	–	–	–	2
12. Peculiar to Pacific Flora,	1	–	–	–	–	1	–	–	–	1	3
V. Pacific Flora.	5	–	–	–	–	1	1	–	1	1	9
Flora of the United States.	36	3	1	2	7	2	6	6	5	12	
	$\underbrace{\hspace{3em}}$ 51						29				80

G. E.

9. *Carex.*—In the third part of the Illustrations of Carex, by Dr. Boott (Lond. 1862, p. 119) the *C. argyrantha*, Tuckerm. (Dew. in Wood's Bot. p. 753) is referred, as stated in this Journal for May (p. 431) to the older *C. adusta*, Boott. But it appears proper to add that the same splendid work upon Carex, which is in few hands, refers (p. 118) the *C. adusta* of Carey in Gray's Manual of Botany (a plant supposed by the describer of *C. argyrantha*, without any doubt, to be Boott's) to another species, and it follows from this, on the high authority cited, that the plant called, as above, *C. argyrantha*—the true *C. adusta* of Boott—was really, as supposed by its later describer, and others, a nondescript, as respects the Manual.

The two plants here in question (*C. adusta*, Carey, l. c., = *C. fœnea*, γ, Boott, and *C. argyrantha*, Tuckerman, l. c., = *C. adusta*, Boott) are nearly akin, but they appear to be quite distinct. E. T.

ZOOLOGY—

10. *Geoffroy St. Hilaire's System of Zoology.*—The death of Isidore Geoffroy St. Hilaire, a distinguished savan and learned zoologist of Paris, was noticed in this Journal for Jan., 1862, p. 149. His system of zoology, "*Hist. nat. Génerale*, Paris, 1856," is not generally known, and may be interesting to many. The synopsis which he gives of his views is short, and I present a literal translation.

"Organized bodies are distributed by St. Hilaire in three kingdoms" . . . . . "thus characterized."

"In the first, only the characters common to all beings, organized and living.

"In the second, the same general characters as in the first, with the addition of sensibility and mobility.

"In the third, which embraces man alone, the same general characters as in the second, with the addition of intelligence.

"In the first, life is all *vegetative.*

"In the second, to vegetative life is added *animal life.*

"In the third, to vegetative and animal life, is added *moral life.*

"And to exhibit in terms still more concise, not only this long chapter but all that precedes,

"The plant *lives;* the animal *lives* and *feels;* man *lives* and *feels* and *thinks.*

"Life is *simple* in the first kingdom, *double* in the second, *triple* in the third.

"Vegetability, animality, humanity; three terms which in this point of view succeed each other in a hierarchical order, manifestly as simple as logical—

"A series where not only no term could be transposed, but to which no term could be added." C. D.

For a synopsis of St. Hilaire's course of Lectures on Zoology see this Journal, [2] xxxii, 431.

IV. ASTRONOMY AND METEOROLOGY.

1. *Account of the great comet of 1858, being vol. 3d of the Annals of the Astronomical Observatory of Harvard College;* by G. P. BOND, Director of the Observatory, 4to, pp. 392, with 57 plates.—This magnificent volume contains a detailed account of the remarkable appearances presented

by the great comet of 1858. It is divided into XV sections. Section I contains the details of observations upon the figure, dimensions and position of the tail. The whole period of visibility of the comet extended from June 2, 1858, to March 4, 1859, an interval of 275 days. It was seen with the naked eye from Aug. 19 to Dec. 9, an interval of 112 days. The tail appeared first on Aug. 14, 1858, and was in sight until Feb. 9, 1859, or for 177 days.

Section II comprises observations upon the secondary tails. These consisted chiefly of long, narrow and nearly straight rays. They were quite faint, and escaped general notice.

Section III gives the details of the reduction of the observations upon the figure and position of the tail. The maximum length of the tail was 64° on the 10th of October; the greatest breadth was 18° on the day following.

In Section IV are considered the probable errors affecting the observations upon the tail.

Section V describes the deflection of the upper part of the tail.

Section VI describes the columnar structure, or the division of the upper part of the tail into alternating dark and bright bands, disposed transversely to the axis, at angles of 20° or 30°.

Section VII contains the reduction of observations on the secondary tails. The principal ray attained a length of 55°.

The original data relating to the envelopes and nucleus, and to the phenomena of the head of the comet generally, are comprised in Section VIII. The citations are made from 71 authorities, representing 51 stations.

The first traces of a peculiarity in the nebulosity near the nucleus, which led finally to the full development of the envelopes, were mentioned on Sept. 11th. The light was seen streaming outward from the nucleus, on the side nearest the sun, bending backward to form the two branches of the tail.

Section IX treats of the outline of the head of the comet. The discussion is based upon 123 outlines, derived from the original drawings or engraved figures. It appears that the limiting surface of the head of the comet had a close resemblance to a surface generated by the revolution of a catenary on its vertical axis.

The phenomena of the branching and central darkness of the tail have been considered in Section X. On the 24th of August, the right branch already showed an excess of light, and the contrast in density went on increasing until it reached a maximum about the time of the perihelion passage.

The size of the nucleus, and the quantity of light emitted by it and by the head generally, form the subject of Section XI. The diameter of the actual solid nucleus must have been less than 500 miles. On the 2nd of October, the brightness of the head of the comet was 6300 times greater than on June 15th, the increase by observation exceeding that computed by the usual formula, by 33 times. The difference is referred to an increase in the aggregate reflecting surface of the comet.

The phenomena presented by the envelopes are considered in Section XII. One of the most important of these is their regular succession, and continuous ascent or expansion outwards from the nucleus. Seven distinct envelopes have been recognized, and their history partially recovered. The period between the elevation of the envelopes is found to have varied irregularly from 4 days 16 hours to 7 days 8 hours.

Section XIII gives an account of the outer faint veil.

Section XIV relates to the deviation of the initial axis of the tail from the direction of the radius vector prolonged. This deviation was estimated at 6° 18′.

This volume contains a more thorough discussion of the physical peculiarities of the comet of 1858 than has ever been published respecting any other comet; and it will probably long continue to be the standard work upon this subject. Its mechanical execution does great credit to the Cambridge press, and the engraved representations of the comet have not, so far as we know, ever been equalled by any similar work at home or abroad.

2. *Comet* II, 1862.—This comet was discovered, at the Dudley Observatory, on the evening of July 18th by Mr. Thomas Simons.

When first seen it appeared as a nebulæ considerably condensed at the centre, the light being intense enough to be easily observed when the wires of the micrometer were illuminated.

On the evening of the 31st the embryo of a tail was distinctly seen, and as early as the 25th the light was more concentrated on one side, showing that the tail was already in process of formation.

As it is now approaching both the earth and sun, and being so favorably situated for observation, it will without doubt attain great brilliancy. At the present time (Aug. 15th) the tail can be traced a distance of 12 degrees.

The following are observations for position:

	M. T. Dudley Observatory.	App. A. R.	App. Dec.
1862, July 18	14^h 20^m $03^s{\cdot}6$	5^h 23^m $57^s{\cdot}58$	$+67°$ $45'$ $05''{\cdot}41$
25	9 22 18 ·0	5 36 24 ·35	$70°$ $13'$ $25''{\cdot}78$
26	9 20 45 ·1	5 38 47 ·78	70 39 04 ·26
Aug. 12	11 05 30 ·2	8 30 51 ·50	81 20 01 ·50

July 18th. Comet compared with 10·5 Mag. star.

18 Comp. A. R. $\Delta\alpha = -6^s{\cdot}45$ 10 Comp Dec. $\Delta\delta = +55''$

The place of the star was determined by three transits at the lower culmination observed with the Olcott Meridian Circle.

1862, July 18th.	10·5* App. A. R.	App. Dec.
	5^h 24^m $04^s{\cdot}03$	$+67°$ $44'$ $10''{\cdot}13$

The observations of July 25, 26 and Aug. 12, were made with the Olcott Meridian Circle at the lower culmination.

Fifteen wires were observed for A. R. and the times of transit recorded on the chronograph by the magnetic method.

The observations are not corrected for parallax.

G. W. Hough, *Assist. Dudley Observatory.*

Communicated by instructions from the Director.

3. ***Companion to Sirius;*** (in a letter to the Editors, by Louis M. Rutherford.)—On the 8th of March last I received the number of your

Journal for that month, and from it learned for the first time that Mr. Clark had discovered a companion to Sirius. The evening proved a good one, and I readily saw the new companion with my equatorial, by Fitz, $11\frac{1}{4}$ in. aperture and 14 feet focal distance. My assistant, Mr. Wakely, also found the new star on the same evening in my absence. No measures were made at that time, but I find on examining the journal of the observatory the following measures recorded; they were made with a filar micrometer and powers of 200 and 400—Mr. Wakely preferring the former and I the latter:

Date.			Pos.	No. of meas.	Dist.	No. of meas.
March	11,	1862.	85° 16′	11	8″·95	1
"	12,	"	not taken.		10″·93	4
"	26,	"	85° 01′	10	10″·24	6
"	27,	"	85° 01′	6	9″·67	3
"	28,	"	85° 24′	5	not taken.	
April	3,	"	85° 04′	6	not taken.	
"	10.	"	84° 20′	10	not taken.	

Since hearing of the existence of this star I have never looked for it in vain; its difficulty is not occasioned by faintness, but by its proximity to so bright an object as Sirius. I consider it decidedly a brighter star than either of the close companions in the trapezium of Orion—no reasonable amount of illumination in the field extinguishes it. On the 6th of April, within five minutes after sunset, I set the circles of the equatorial and found Sirius, the daylight being abundant to read the divisions, the companion was then quite distinctly visible; and on the 10th of April Mr. Wakely's measures were taken by daylight.

From these circumstances I should be inclined to think this new star variable, since it has hitherto escaped the scrutiny of many observers armed with sufficient optical power to see it; or perhaps it must be added to the long list of evidences, that it requires a far greater power to make a new discovery than to recognize it when known.

New York, July 28, 1862.

4. *The Meteors of August* 10*th*, 1862.—It is probable that the full moon which occurred this year at the August period has interfered to a great extent with the usual observations. There are, however, certain respects (photometric especially) which confer special value upon the phenomena as exhibited through a screen of mild light just sufficient to obliterate the faint lines and leave none visible but the stronger and more brilliant. The records which have thus far reached us the present month come from the observers, Mr. B. V. Marsh and Mr. F. W. Russell. The station of the latter the present year was Winchendon, Mass., lat. 42° 40′, lon. 72° 12′. We remark, in anticipation of the observations given below, two points especially:—

First. The radiant on the morning of the 9th, although determined by only a few flights, is stated decidedly as a circle of "5° diameter, including delta Cassiopeiæ." But on the morning of the 10th it was "in A. R. 41° 40′, and N. P. D. 35° 15′." This change of position, although excessive, coincides—to a near parallelism—with the changes marked and suggested, as an invariable phase of these phenomena, upon our fragmentary chart given last year at p. 445 of vol. xxxii. The subsequent observations of the record do not particularly confirm this motion; neither are they sufficiently definite to discredit it.

Second. One meteor appeared "in the radiant" as "a stationary point of brightness." This is a fourth instance added to the three narrated in connection with our chart above specified. A phenomenon thus repeatedly witnessed certainly deserves attention, on account of the overwhelming improbability that either meteor of so limited a number should be directed so exactly in the line of vision.

Mr. Russell's record is the following:—

"*Saturday, Aug. 9th.*—One hour. Two to three o'clock, A. M., 8 meteors, with radiant a circle of 5° diameter including δ Cassiopeiæ.

The moon being nearly full embarrassed the view, as did also the mist. The meteors seen were embraced in a circle of 30° or 40° radius about Perseus. All but one or two radiated about the constellation Cassiopeia but exhibited no decided *point.* Perhaps a large circle of 5° diameter, including δ, would embrace five or six of the flights.

Sunday, 10th.—Two observers—W. G. Bryant and myself. 2h to 3h, 40 meteors. 3h to 3h 40m, 50 meteors. 1h 40m, 90 meteors. The radiant I determined to be a circle of 1° 55′ to [1°] 59′ radius, having its centre very nearly in A. 41° 40′ R. and N. P. D. 35° 15′, or very nearly in centre of triangle formed by *η-γ-k* Persei of Burritt's maps. About one-third of the meteors were in the N.E. and the remainder in the N.W. Of the meteors which I observed in the east all but two were conformable, or at least approximately conformable. Of the last none passed more than one or two degrees outside of the circle. The largest meteor perhaps equalled Mars in brightness, 15 having trains. *A stationary point of brightness was observed in the radiant* once. This radiant conforms very closely to that of 10th and 11th of Aug., 1861, as stated by B. V. Marsh. (This Journal, Sept., 1861.)

P. M.—Began observing at 9h. 9h to 10h in east 13, all but one conformable, in west 10, one with train. 10h to 11h in east 6, in west 4, all small. Shortly after the latter hour the clouds, which had been increasing since 9h, caused so much embarrassment that the watch had to be given up. Those meteors seen after 9h appeared to radiate from the position of the previous morning, but the clouds prevented any very accurate determination of its exact position. Besides the above, while we were arranging for the watch, we saw seven of the largest meteors of the evening, two with trains, all radiating from Cassiopeia.

Resume.—10th of Aug., 8h 40m to 11 P. M.—2h 20m—40 meteors. Of 20 all but two conformable, three with trains. Evident radiant same as previous morning.

Monday, 11th.—One hour. 8h to 9h P. M. 4 meteors. One with train, three radiating from near δ Cassiopeiæ, and the other (the first observed) nonconformable.

Clouds prevented observations on the mornings of 11th, 12th and 13th. On the evening of 13th saw two meteors, within a few minutes, radiate from Perseus. This shows that the thickness of the "ring" is probably near twelve millions of miles, the earth being six or seven days in passing through it."

Upon the above record we remark farther that whether the ninety meteors seen on the morning of the 10th by two observers in $1^h\ 40^m$ are to be divided equally between the two to obtain the rate for a single observer is not clear; because it is not stated whether their attention was directed to the same or to different quarters or spaces of the heavens.

The following valuable observations have been furnished, as made by himself, by Mr. Benj. V. Marsh in a letter to Prof. H. A. Newton:

Meteors observed at Germantown (near Philadelphia), Pa.

"1862, Aug. 11. From 0^h 30^m to 1^h 0^m A.M., 11 meteors.

1	0	"	1	15	"	4
1	15	"	1	30	"	1
1	30	"	1	45	"	5
1	45	"	2	0	"	3
2	0	"	2	15	"	7
2	15	"	2	30	"	4
2	30	"	2	45	"	4
2	45	"	3	0	"	7
3	0	"	3	15	"	1
3	15	"	3	30	"	4

Total, 51 meteors in 3 hours.

Weather perfectly clear, full moon shining.

Nearly all the above were conformable—approximately at least—only two being observed that were certainly altogether unconformable, but the direction of motion in several was uncertain because of the shortness of their path and their not being in the direction to which the principal attention was directed.

The most brilliant were as follows:

At 0 26½, north of Capella.
 0 28½, in the north.
 2 10, near β Persei—splendid—left a wavy streak which was visible 5 or 6 seconds.
 2 16, near β Persei—streak lasting 1 to 2 seconds.
 2 34, in S.E.—streak lasting 1 or 2 seconds.
 3 2½, in Cassiopeia.

Much the finest was at 2 10."

It is greatly to be desired that some of the meteors above reported by Mr. Marsh (particularly the 2^h 10^m near β Persei) may be identified by observers at other places. If any observer suspects an identity with his own, in this or in either of the instances, he is invited to communicate all the particulars of his observations,—as Mr. Marsh is understood to have corresponding particulars on record with which a comparison may be made.

ALEX. C. TWINING, *for the Com. of Conn. Academy.*

5. *On some North American Meteorites;* by C. F. RAMMELSBERG.—Rammelsberg has communicated to the Berlin Academy of Sciences an examination of the meteoric stone from Bishopville, South Carolina. His results differ materially from those obtained by Shepard and Sautorius von Waltershausen. He concludes that the siliceous portion of the stone is not a simple compound, but probably a mixture, and that the assumption that it contains a supposed trisilicate of magnesia ($\dot{\mathrm{Mg}}\,\dddot{\mathrm{Si}}$)—the chladnite of Shepard—is not justified by the observed facts. His analysis of the stone gave,

$\dddot{\mathrm{Si}}$	$\mathrm{\bar{A}l}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	Ign.
57·52	2·72	1·25	0·20	34·80	0·66	1·14	0·70	0·80=99·79

Rammelsberg observes that this composition somewhat resembles that of the olivine-like substance from the Grimma meteoric-iron analyzed by Stromeyer in which the latter found $\dddot{\mathrm{Si}}$ 61·88, $\dot{\mathrm{Mg}}$ 25·83, $\dot{\mathrm{Fe}}$ 9·12, $\dot{\mathrm{Mn}}$ 0·31

Ċr 0·33, Ign. 0·45=97·92. The resemblance is more marked, if the protoxyd of iron in the analyses be converted into its equivalent weight of magnesia.*

Rammelsberg also presented to the Academy, the results of the examination of three so-called meteorites, which Dr. Hörnes of Vienna, had received from Prof. C. U. Shepard of Amherst College. In communicating the specimens to Rammelsberg, Dr. Hörnes remarks that they are certainly *not* meteorites. The results were as follows:

I. *So-called Meteoric Stone from Waterloo, Seneca County, New York.*—According to Shepard it contains: S̈i 78·8, Al 6·28, Fe 8·72, Ḣ 4·75, Ċa, Ṁg (in equal quantities!) and loss 1·45. Rammelsberg considers that this is without doubt nothing more than a ferruginous clay. It is for the most part decomposed by chlorhydric-acid, contains much more alumina than above indicated, and 6 pr. ct. of water. On heating it becomes brick-red.

II. *So-called Meteoric Stone from Richland, near Columbia, South Carolina.*—It is a yellow to gray mass, showing occasional blackish points, and small lustrous kernels of what appears from the hardness to be quartz. Analyses by Shepard and Rammelsberg gave,

S̈i	Al	Fe	Ṁg	Ċa	Ign.		
80·42	15·68	2·79	0·70	0·50	——	= 100·09	Shep.
70·42	20·25	3·86	4·47	1·21	1·28	100·49	Ramm.

Rammelsberg found that chlorhydric acid had very little action on the substance. He considers that this is also a clay, and suggests that perhaps it is a fragment of a brick.

III. *So-called Meteoric Iron from Rutherford, North Carolina.*—This mass, in which Shepard found, Fe 84·00, Si 13·57, P 1·31, and according to a partial analysis made in Wöhler's Laboratory contains, Fe 87·1, Si 10·6, C 0·4, is considered by Rammelsberg as nothing more than a piece of white pig iron of inferior quality. He found it difficultly attacked by acids and determined it to contain 15·7 pr. ct. of silicon.—*Journal für praktische Chem.*, lxxxv, 87. G. J. B.

6. *Bullettino Meteorologico dell' Osservatorio del Collegio Romano* con Corrispondenza e bibliografia per l'avanzamento della fisica terrestre. Roma, March 1st, 1862—bi-weekly.—We have received the first 10 numbers of this Meteorological Journal published at Rome, Italy. The Nos. are issued once a fortnight, each No. consisting of eight large quarto pages, beautifully printed. They contain the meteorological, magnetic and electric observations made at the Roman College under the direction of Father Secchi, with full meteorological notes, and also dissertations upon various questions relating to terrestrial magnetism, to atmospheric electricity, the electric currents, the atmospheric pressure and temperature. We anticipate much valuable information from this new vehicle of meteorological science.

* From some investigations made by Prof. J. Lawrence Smith he had been led to think that chladnite might possibly prove to be a pyroxene. See this Journal, [2], xix, 163.

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Editorial Correspondence—The Spectroscope.*—The following letters from Professors COOKE and ROOD contain interesting observations with the spectroscope, which is hereafter to be regarded as an indispensable auxiliary in the working laboratory. The instrument of Mr. Clark, with which Prof. Cooke's observations were made, has a prism of flint glass of about four inches on each face which is built up of several thicknesses of plate glass cemented together by Canada balsam. This construction facilitates the use of a large prism at a small cost, and the lines of junction are of no optical importance.

CAMBRIDGE, July 28, 1862.

My dear Silliman:—I have a few moments, before leaving Cambridge for the vacation, to make good my promise and give you the results of my experiments with Clark's spectroscope. It has worked wonders in splitting up the various colored bands of the different spectra. You know that the yellow sodium band is doubled. I have succeeded in separating them, at least a sixteenth of an inch still retaining good definition. The red line of potassium is also double, the two members being even wider apart than those of sodium. The red lithia line, I think, is also double, but it is possible that I may here be deceived by the effect of diffraction similar to that described by Dr. White in a late number of your Journal. The most remarkable result is that with the broad orange band of strontium. It divides up into a large number of bands or rather it appears as an orange space covered by a large number of black lines apparently perfectly similar to the Fraunhofer lines. On many of the other bands I have caught glimpses of similar lines, but the light has been so feeble that the results have not been equally satisfactory. In order to see them it is necessary to reduce the width of the slit to about the same size as that required to show the Fraunhofer lines, but with the ordinary appliances long before this point is reached the light from most of the bands has become too feeble to be perceptible. I find that by flashing the salts into the flame the intensity of the light is greatly increased and I hope I may in this way succeed in figuring the dark lines of the salt spectra at least tolerably well. The colored bands of these spectra are therefore no longer to be regarded as bands of light complementary to the Fraunhofer lines, but as colored spaces themselves crossed by dark lines. The bearing of these facts on the ingenious solar theory of Kirchhoff and Bunsen is evident. Very truly, your friend,

JOSIAH P. COOKE, JR.

2. *On prisms of Bisulphid of Carbon for optical purposes,* (from a letter of Prof. O. N. ROOD to Prof. B. SILLIMAN, Jr.).

Dear Professor:—I send you a stereograph of a large spectroscope with *four prisms*, which I have lately constructed for use in my optical studies. While the general arrangement is similar in principle to that employed by Kirchhoff in his large instrument, the construction of the prisms is peculiar and may be of interest to you. Three of the prisms are hollow, and filled with bisulphid of carbon, the fourth is of flint glass, the angles being respectively, 60°, 60°, 60°, and 45°. The frames of the prisms were made of cast iron; after the faces had been worked nearly true, plane, parallel plates of glass were cemented on the sides with a mixture of glue and molasses. After a few days bisulphid of carbon was poured in through an opening which was then closed by a screw. So far the construction was old, and attended with a most serious defect which has perhaps prevented the general introduction of these prisms, for if the light from the slit be allowed to fall on a face of a prism thus prepared, and reflected from it along the axes of the observing telescope, it will be found that the image of the slit is *distorted* to a greater or less degree; farther examination shows that the glass plate has been slightly bent by the hardening of the glue, and in those of my preparation the curvature was concave. If two or more such prisms are used for the production of a spectrum a certain amount of confusion is always seen among the fixed lines; plates of glass of even ^{1} of an inch in thickness are constantly affected in this manner, and unless the evil be removed the prisms are of no great value.

After many vexatious failures I have perfectly corrected this difficulty in a very simple manner: the prisms are finished in the way above described with glass of good quality, then a few drops of olive oil are placed on one of the faces and a plate of truly plane glass laid on it; the oil spreads out and is held in position by capillary attraction, the four corners are then secured by four drops of melted wax and resin. Optical contact is thus secured, and the slight curvature corrected: each face is in turn thus dealt with. The substitution of Canada balsam for oil I have also tried, but it is impossible under several months to offer any opinion on its merits. Large prisms of bisulphid of carbon thus corrected, while remarkably cheap, approach, I think, a degree of optical perfection not attainable by the best flint glass prisms yet produced, for even if the flint prism is of equal size with that of bisulphid of carbon, and optically unexceptionable, the fact still remains that the dispersive power of the latter is greater.*

With three such prisms of 60°, and a flint glass prism of 45°, a ray of light is refracted about 180°, a spectrum furnished which with the power I employ is ten feet long, the lines being as clear and sharp as those in an engraving, while the light is more than abundant. In examining the solar spectrum with this apparatus I have discovered many lines not laid down in Kirchhoff's new and most admirable chart of the solar spectrum; I mention now merely two new lines in the interior of the line D, making in all three fine lines which are enclosed in this double line.

Encouraged by the excellent performance of these prisms, I am now engaged in constructing for my investigations a large instrument in which the refraction is to be effected by from eight to ten of these prisms, carrying thus into effect a suggestion made by Kirchhoff some few weeks ago in his paper on the solar spectrum.

Before closing this letter one practical point remains to be alluded to: it is not essential that the plates of glass should have truly *parallel* sides, provided that the plates are cut in such a manner that their plane of refraction coincides with the plane of refraction of the prism. Sincerely,

Troy, Aug. 7th, 1862. O. N. ROOD.

3. *Ascent of the Volcano of Candarave, Peru,* (about lat. 18° S., lon. 70° W.), in a letter from WALTER STUART CHURCH, Esq., Civil Engineer in the service of the Peruvian Government.—"We made the ascent of the volcano of Candarave on Monday, the 12th of May with the Arriéro and Lieut. Governor of Candarave. Finding that it would be too much for a single day, we started at 2 o'clock on Sunday to seek lodgings at the base. The Governor was backing out at the last moment, when we found an opportune auxiliary in a Padre, who returning from mass stopped to give us directions about the best road, and urged the Governor to go with us. The Indian villagers however gathered about us, smiling at our making

* While in Munich in 1857, I requested Prof. Steinheil to give me a flint glass prism having the greatest attainable dispersive power. He furnished me at once with a prism which had what might be called an impracticably high dispersive power, stating that it was a failure, the amount of oxyd of lead being so great that the surfaces tarnished in a very few months. I have compared this prism with bisulphid of carbon prisms, and find that the dispersive power of the latter is greater.

an attempt in which we should be sure to fail, for the mountain, according to tradition, "would *swallow* us." At sunset we reached a single Indian hovel well up the mountain. Its only inhabitant was a little child of some ten years, who was much terrified at our approach and cuddled under the bed-clothes to have a cry, but the offer of bread, which it devoured voraciously, and kindly treatment pacified it. The mother (an imbecile) had gone 10 miles for squashes and would not return for a day or two. We removed the cobble-stones piled in the door way of the hut, and made ourselves at home, as best we could. Our stupid cook had by mistake substituted tobacco for coffee, forgot the tea altogether, and put the milk into a dirty can which had soured it, so our precautions for a comfortable meal were futile. However, the arriéro got up a savory "chupe," while Delgardo and I amused ourselves looking on. An old Indian traveler happened along, and joined our chowder-party, greatly surprised at encountering us. The Governor pressed him for our guide next day, as by his account we were much off our road.

The night was a remarkably mild one at an elevation of 12,850 feet, and at 6 the next morning we were in the saddle climbing the mountain's base. We pushed the poor beasts to their utmost capacity, far above the snow-line, among the Andes' lilies, and balls of hard sponge-like looking moss, and passing to the N.W. escaped the deeper snow, which in all these sierra is melted almost entirely from the inland side, by the warmer winds. We attained at 20 minutes to 9 the very cone where the sandy sides were interrupted by a mane of ragged rocks. Here the Indians stopped, and neither persuasion, bribes nor threats would make them budge. They valued their lives more than anything else, and we were sure to be "swallowed" if we went up. They would hold the beasts—watch us, and offer ovations of coca to the mountain Deity for our safe return! So away we went on foot, climbing very slowly over the loose rocks, and resting at short intervals to enjoy the scene, which became grand beyond description. Three long hours and more we struggled up—the path growing steeper and steeper, until 12 M., when we stood on the lowest edge of the crater's lip, broken away by the huge rocks it had heaved out. Respiration became difficult, and the poor arriéro could hardly move. I carried the barometer, fearing to trust even my companion with it. They told me I was very pale; it certainly required great effort to climb round the rising edge of the great hole we had reached, to a bluff, forming its summit, when directly the "Soroche," or "Puna," as the natives call it, overcame me. This affection is very similar to sea-sickness—it attacks some persons very violently, belching blood from nose and ears."

[Baron Tschudi says of this affection—"In the heights of the Cordillera the effect of the diminished atmospheric pressure on the human frame shows itself in intolerable symptoms of weariness and an extreme difficulty of breathing. The natives call this malady the *Puna* or the *Soroche*, and the Spanish Creoles give it the names of *Mareo* or *Veta*. Ignorant of its real causes they ascribe it to the exhalations of metals, especially antimony, which is extensively used in the mining operations. The first symptoms of the Veta are usually at the elevation of 12,600 feet above the sea. These symptoms are vertigo, dimness of sight and hearing, pain in the head and nausea. Blood flows from the eyes, nose, and lips.

Fainting fits, spitting of blood, and other dangerous symptoms, usually attend severe attacks of Veta. The sensations which accompany this malady somewhat resemble those of sea sickness, and hence its Spanish name *Mareo.* But sea-sickness is unaccompanied by the distressing difficulty of breathing experienced in the Veta. This disorder sometimes proves fatal, and I once witnessed a case in which death was the result."*]

I had fortunately but a slight attack, and soon felt relieved enough to take an observation, which, to our great surprise, showed us to be 18,962 feet above the sea—more than 3000 feet higher than Mount Blanc and 250 higher than the "*Misty*" near Arequipa, as measured by Humboldt. Our view had widened into a command of the whole sierre and its ramifications, hundreds of miles in area. To the south and west lay the lagoon of Candarave,—our mountain road back to Tacna, joined on the east by a long ridge, over which ran a water course (Acquia) to the volcano of Zutupaca,—the snow-tops running towards Arequipa. Northward stretched the Alto of Puma, and northeast, the red rocks of the Machita Pass peeping out from the snow in strong contrast. Just above Tarrata, nearer our base, we saw the several Quebradas, furnishing outlets for the thaws through the rivers Totona, Caijasso and Pasto Grande—and away beyond all, the blue sea, which *they never reach*, being quite dissipated in irrigation.

There was little interesting in the crater itself, dormant some 83 years—no lagoon or birds, as reported, only a little frozen puddle, the drainage of a diameter of some 400 feet, and a depth of perhaps 100—and only two or three small bits of sulphur. Descending we took the sand or volcanic ashes which, as on Vesuvius, lie at a steep angle of repose, making an easy path for the weary climber on his return. Behind lie two smaller peaks from which the Indians gather sulphur for market. In the base of the nearest is a huge hole, which but for its elevation we should have supposed to be the entrance to a mine, the vent perhaps of a lateral eruption. Towards it we traced the huge tracks of a cougar. We continued on foot to the Indian hovel, which we reached at sunset—the little child was gone. We mounted our mules just as the full moon rose and reached the village, 12 miles off, at $6\frac{1}{2}$, A. M."

4. *Retorts.*—The retort is one of the chemist's most useful instruments, and yet, while such great improvements have been introduced into chemical apparatus generally, it is still made of the old shape, with little or no variation.

With very little additional trouble, our glass houses might make retorts such as would be of the greatest convenience to chemists. In a great many operations the stem of the retort is raised, so that liquids may flow back, and only gases pass over: in these cases it is difficult to make a tight fit with a cork, inasmuch as the latter only touches the glass at a single line, and if much force is used the glass breaks. Retorts should be made for this express purpose, with the stem finished like the neck of a flask. Again, flat-bottomed flasks have almost entirely taken the place of round-bottomed; why should we not have flat-bottomed retorts? Then too when dry substances are to be distilled, it would be convenient to have retorts with their tubes diminishing to quite a small size, in order to be connected by india rubber tube with ordinary sized glass tube.

* Travels in Peru, p. 207, (American edition).

This form would also be convenient for the purposes first above referred to. It is true that this last form is often given to the necks of retorts by the chemist himself with the blowpipe. But it would be convenient to have the time saved which is wasted on this mechanical work, and it would be better done in the glass-house. Any manufacturer who would give his attention to these matters would confer a benefit on chemists, and would doubtless find his account in doing so. M. C. L.

5. *Old friends with new faces.*—Sometime since it was urged that the word "telegraph" as applied to the dispatch sent was ambiguous and liable to be mistaken for the instrument itself, and the new word "telegram" was coined to remove the objection. Somewhat reluctantly the new comer was admitted, and now we are asked to consent to "photograms."* If we assent to this innovation how can we object to paragrams, autograms and lithograms?

OBITUARY.

Marcel de Serres died on the 22d of July at Montpellier (France) in the 82d year of his age. He was a corresponding member of the Academy of Sciences at Paris, and Professor of Geology in the Faculty of Sciences at Montpellier. He belonged to the same family with the celebrated Agriculturist, Olivier de Serres, a family famous in civil life, he himself having exercised the functions of a Councilor from 1814 to 1852, and published a work in 3 volumes entitled: *Manuel des Cours d'Assises.* But his reputation rested chiefly upon his scientific labors, especially in the department of philosophical natural history. He belonged to a class of *Savants* rare now-a-days, who embraced at one grasp all branches of science, seeking rather to illustrate one by another than to apply himself exclusively to advancing the progress of one alone. He thus studied plants and animals in their mutual relations to both living and fossil species, the laws of the succession of species on the globe, their geographic distribution, and in some cases their anatomy as well as their physiology. His original researches embrace a wide range, e. g., in comparative anatomy we have his Memoir on the eyes of Insects; in Geology and Palæontology are his researches on Caverns and their bones; and those in the Tertiary deposits. He published an extended work on the Mosaic Cosmogony and its relation to Geology, and others on pure Geology and Mineralogy, while his *Mémoirs sur les terrains du midi de la France* occupy an important place in the history of Geology. He was the pupil of the most distinguished masters of the last generation, of Haüy, Alex. Brongniart and of the leaders in moral and ethical sciences, having been originally destined for the church. A commission from Daru, *intendent général* of the great army then in Austria, called him in May, 1809, to Vienna as inspector of Arts and Manufactures, a commission which resulted in great benefit to the arts, manufactures, agriculture and commerce of France. The new documents which he collected during this military journey furnished the material of sixteen volumes, which appeared under various titles from 1814 to 1823. He was a man of vast industry and untiring energy, filling with exactness his post as Councilor of the Court, he discharged with zeal his duties as Professor, printing at the same time in the Scientific Journals, memoirs on zoology, palæontolology, geology, while he published in

* Sabine, Phil. Mag. Dec., 1861, p. 479.

the industrial Journals details relative to processes upon which he had collected notes. Few men have lived whose existence was more completely filled than that of Marcel de Serres; few savants have displayed greater activity and found themselves in a position so favorable to render service to science. With mere ambition, and in another field, he might have reached a high station in the State, but his desires were not in the direction of political distinction. Simple in his tastes, kind and polished in his relations, more devoted to science than sensible to the honors to which it led, he seemed neither to doubt or to cultivate his own reputation; happy without applause and famous without ostentation.

H. H. de Senarmont: died very suddenly (aged 56 years) at Paris on the 30th of June at 2½ o'clock A. M., of syncope consequent on inveterate gout. The appreciation of his loss was such in Paris that the Academy of Sciences immediately adjourned on hearing of the decease of their distinguished associate. To quote the words of the Secretary, "In the state of general consternation which this unexpected news had produced on the Academy and upon the public which had come in to attend the session, they could think of nothing but their sad loss. Therefore on the motion of Messrs. Chevreul and Combes, who appeared as the organs of the public grief, the assembly dispersed, the prey of the most lively emotion."

His death leaves a great void in the Academy. He will be keenly missed by all the younger men of science whom he loved to encourage and of whom he was the eloquent advocate.

Mr. de Senarmont was Professor of Mineralogy in the School of Mines at the time of his death.

Dr. Henrich Georg Bronn: Professor of Natural History in the University of Heidelberg, Baden, died suddenly of disease of the heart at 3½ o'clock, P. M., on the 5th of July, in the 62d year of his age. This death is a great loss to science. Dr. Bronn was a most successful and laborious author in Palæontology. Since 1824 his contributions to Zoology, Geology, Mineralogy and Palæontology have been unceasing. The list of titles of his contributions in zoology and geology alone in Agassiz's Biblig. Zoolog., reaches thirty-eight, up to 1848, only. His great work *Lethæa Geognostica*, appeared in a new edition from 1851 to 1856. Since then he has been chiefly occupied with an elaborate illustrated Treatise entitled, "Die Klassen und Ordnungen des *Thier-Reichs* wissenschaften dargestelt in Wort und Bild."

This remains incomplete, the last part which has reached us being No. 16 of the 3d volume, containing Malacozoa.

His *Index Palæontologicus*, 3 vols., 1848–49. Part 1st, *Nomenclator palæontologicus*, A–Z, pp. 1381 and Pars 2d, *Enumerator palæontologicus*, pp. 980, is one of those works of vast and exhausting labor which few have the courage or knowledge to undertake, but the value of which, as of a good lexicon is inappreciable: would it could be brought down to date!

On the 23d of January, 1862, he lost his old teacher, colleague and co-editor, Prof. Leonhard. The Journal (Neues Jahrbuch für Mineralogie, Geologie, etc., Heidelberg, 1830–1862) so long associated with the names of Leonhard and Bronn, will be continued by the same title and under the same names. Prof. Bronn leaves two sons, Leopold and Henrich G.

General Isaac I. Stevens, U. S. A., was killed in an engagement near Fairfax Court House, Virginia, Sept. 1, 1862. His labors in the explorations and surveys on the 49th parallel north latitude, when Governor of Washington Territory, form a valuable addition to our knowledge of the Physics and Geography of the North American continent.

VI. PROCEEDINGS OF SOCIETIES.

Proc. Boston Soc. Nat. Hist. (continued from p. 304, vol. xxxiii) 1861. Vol. viii. —NOVEMBER.—224, The Acalephan Fauna of the southern coast of Massachusetts (Buzzard's Bay); *Alex. Agassiz* (oral communication).—226, Homologies of Radiata; *L. Agassiz.*—233, Chemical analysis of a Meteoric Stone from Dhurmsalla, India; *C. T. Jackson.*—235, On the Homologies of Echinoderms; *L. Agassiz.*—239, The Taconic and Lower Silurian Rocks of Vermont and Canada; *J. Marcou.*—253, Note on cleaning Diatomaceæ; *Arthur M. Edwards.*—255, On Melania (Amnicola) Lapidaria; *James Lewis.*—256, Preparation of the bones of a supernumerary leg from a goose; exhibited by *Prof. Wyman.*—257, Report of the Building Committee, presenting a plan for the New Hall of the society, fire-proof, spacious, and convenient for the Library and Cabinet, to cost about $62,000.—258, Specimen of Domeykite from the vicinity of Portage Lake, Lake Superior; presented by *Dr. C. T. Jackson.*—258, Account of 27 specimens added to the department of Comparative Anatomy: being the animals suffocated by smoke from a fire in Goodwin's Menagerie; *Dr. T. C. White.*—DECEMBER.—261, On new Genera and Species of Starfishes of the family Pycnopodidæ (*Asteracanthion* Müll. and Trosch.); *William Stimpson.*—273, Descriptions of two new species of Shells; *Temple Prime.*—274, Lateral symmetry in Brachiopoda; *N. S. Shaler.*—280, Descriptions of new Genera and Species of Shells; *A. A. Gould.*—284, Discussion on the depth at which animal life exists in the sea; *Marcou, Gould, Agassiz,* and *Dr. J. Pickering.*—285, On the eyes of a Horse Mackerel, exhibited by *Dr. B. J. Jeffries.*—285, On the geology of Anticosti Island, in the Gulf of St. Lawrence; *N. S. Shaler.*—289, Observations upon the Rocks of the Mississippi Valley which have been referred to the Chemung Group of New York, together with Descriptions of New Species of Fossils from the same horizon at Burlington, Iowa; *C. A. White* and *R. P. Whitefield.*—Vol. ix, 1862. JANUARY.—2, On the Structure of the valve of the Diatomaceæ; *Charles Stodder.*—FEBRUARY.—8, Description of new species of Fossils from the Devonian and Carboniferous Rocks of the Mississippi Valley; *Charles A. White,* of Burlington, Iowa.

Proceed. of Acad. Nat. Sci. Philad., 1861 (continued from vol. xxxii, p. 160). —DECEMBER.—p. 391, Descriptions of Eleven new species of the genus Unio from the United States; *Isaac Lea.*—393, Descriptions of seven new species of the genus Io; *Isaac Lea.*—394, A revision of the species of Baculites, described in Dr. Morton's "Synopsis of the Cretaceous group of the United States;" *W. M. Gabb.*—396, On the Mollusca of Harper's Ferry, Virginia; *Geo. W. Tryon, Jr.*—399, On Squalus Americanus, Mitchell, referring it to the genus Odontaspis, Agassiz; *Chas. Conrad Abbott.*—402, Monograph of the species of Sphærium of North and South America; *Temple Prime.*—409, Descriptions of new Palæozoic Fossils from Kentucky and Indiana; *Sidney S. Lyon.*—414, Descriptions of three new species of Mollusca of the genus Sphærium; *Temple Prime.*—415, Descriptions of new Lower Silurian (Primordial), Jurassic, Cretaceous, and Tertiary fossils, collected in Nebraska, by the Exploring Expedition under the command of Capt. Wm. F. Raynolds, U. S. Top. Engrs.; with some remarks on the rocks from which they were obtained; *F. B. Meek* and *F. V. Hayden.*—448, Description of New Plants from Texas; *S. B. Buckley.*—463, Description of a new Quadrumanous Mammal, of the genus Midas; *J. H. Slack.*—465, Synopsis of the recent species of Gastrochænidæ, a family of Acephalous Mollusca; *Geo. W. Tryon, Jr.*—494, On the genera Panolopus, Centropyx, Aristelliger and Sphærodactylus; *E. D. Cope.*—501, Synopsis of the Sillaginoids; *Theodore Gill.*—505, Description of a new species of Sillago; *T. Gill.*—507, Synopsis of the Chænichthyoids; *T. Gill.*—510, Synopsis of the Harpagiferoids; *T. Gill.*—512, Synopsis of the Notothenioids; *T. Gill.*—522, Observations upon certain Cyprinoid fish in Pennsylvania during the summer of 1861: oral communication; *E. D. Cope.*—524, Remarks of the Ailanthus Silkworm: oral communication; *Dr. Stewartson.* 1862. JANUARY.—p. 2, Notes on some of the American Ash trees (Fraxinus), with descriptions of new species; *S. B. Buckley.*—5, Descriptions of new plants from Texas: No. 2; *S. B. Buckley.*—10, On the uniformity of Relative Characters between Allied Species of European and American Trees; *Thos. Meehan.*—13, Notice of a new species of Hemilepidotus, and remarks on the group (Temnistiæ) of which it is a member; *T. Gill.*—14, On the subfamily of Argentininæ; *T. Gill.*—15, Appendix to the Synopsis of the subfamily of Percinæ; *T. Gill.*—16, Note of the Sciænoids of California; *T. Gill.*—FEBRUARY.—21, Descriptions of new Cretaceous fossils from Nebraska Territory, collected by the expedition sent out by the Government under the command of Lieut. John Mullan, U. S. Topog. Eng., for the location and construction of a wagon road from the sources of the Missouri to the Pacific Ocean; *F. B. Meek* and *F. V. Hayden.*—28, Monograph of the species of Sphærium of North and South America; *Temple Prime.*—38, Note on the classification of Cerambycidæ, with descriptions of new species; *John L. LeConte.*—43, Synopsis of the Mordellidæ of the United States; *John L. LeConte.*—52, Note on the species of Calosoma inhabiting the United States; *John L. LeConte.*—54, Descriptions of certain species of Diurnal Lepidoptera found within the limits of the United States and British America: No. 2; *Wm. H. Edwards.*—58, Description of a new Cardium from the Pleistocene of Hudson's Bay; *Wm. Stimpson.*—59, Additions to the nomenclature of North American Lepidoptera; *Aug. R. Grote.*—60, Synopsis of the species of Holcosus and Ameiva, with diagnoses of new West Indian and South American Colubridæ; *E. D. Cope.*—82, Monograph of the species of Trogosita, inhabiting the United States; *Geo. H. Horn.*—88, Descriptions of Plants: No. 3; *S. B. Buckley.*—100, Note No. 2: On Quercus heterophylla, Mich.; *S. B. Buckley.*—MARCH.—102, Synopsis of the family of Cirrhitoids; *T. Gill.*—122, Description of a new species of Cirrhitus (*Cirrhitus alternatus*); *T. Gill.*—124, On the limits and arrangement of the family of Scombroids; *T. Gill.*—127, Descriptions of new species of Alepidosauroidæ; *T. Gill.*—132, On a new species of Priacanthus discovered in Narragansett Bay, R. I.; *T. Gill.*—133, On an oceanic Isopod found near the southeastern shores of Massachusetts; *Wm. Stimpson.*—134, On the West African genus Hemichromis and descriptions of new species in the Museums of the Academy and Smithsonian Institution; *T. Gill.*—140, Catalogue of the Fishes of Lower California in Smithsonian Institution, collected by Mr. J. Xantus; *T. Gill.*—151, On some new and little known American Anura; *E. D. Cope.*—APRIL.—161, Notes upon the "Description of new plants from Texas, by S. B. Buckley," published in the Proceedings of the Academy of Natural Sciences, Dec. 1861 and Jan. 1862; *Asa Gray.*—168, Descriptions of ten new species of Unionidæ of the United States; *Isaac Lea.*—169, Description of a new genus (Trypanostoma) of the family Melanidæ, and of forty-five new species; *Isaac Lea.*—176, Description of two new species of exotic Uniones and one Monocondylœa; *Isaac Lea.*—176, Contributions to Neotropical Saurology; *E. D. Cope.*—188, On Neosorex albibarbis; *E. D. Cope.*—189, On Lacerta echinata and Tiliqua dura; *E. D. Cope.*—191, On the classification and synonymy of the recent species of Pholadidæ; *George W. Tryon, Jr.*—221. Descriptions of certain species of diurnal Lepidoptera, found within the limits of the United States and of British America: No. 3; *Wm. H. Edwards.*—226, Synopsis of the North American forms of the Colymbidæ and Podicipidæ; *Elliott Coues.*—233, On a new genus of Fishes allied to Aulorhynchus and on the affinities of the family Aulorhynchoidæ, to which it belongs; *Theodore Gill.*—235, Remarks on the relations of the genera and other groups of Cuban fishes; *Theodore Gill.*—242, Catalogue of the Fishes of Lower California in the Smithsonian Institution, collected by Mr. J. Xantus: Part II; *T. Gill.*—246, Descriptions of two new species of Vespertilionide, and some remarks on the genus Antrozous; *Harrison Allen.*—MAY.—249, Catalogue of the Fishes of Lower California in the Smithsonian Institution, collected by Mr. J. Xantus: Part III; *T. Gill.*—262, Description of a new genus (Goniobasis) of the family Melanidæ and eighty-two new species; *Isaac Lea.*—JUNE.—272, Descriptions of eleven new species of Melanidæ of the United States; *Isaac Lea.*—274, Notes of a collection of the Fishes of California presented to the Smithsonian Institution by Mr. Samuel Hubbard; *Theodore Gill.*—282, Synopsis of the species of Lophobranchiate Fishes of Western North America; *Theodore Gill.*—284, Descriptions of new genera, subgenera and species of Tertiary and Recent shells; *T. A. Conrad.*—291, Revision of the Gulls of North America: based upon specimens in the Museum of the Smithsonian Institution; *Elliott Coues.*—312, Catalogue of Birds collected by the United States North Pacific Surveying and Exploring Expedition, in command of Capt. John Rodgers, United States Navy, with notes and descriptions of new species; *John Cassin.*

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[SECOND SERIES.]

Art. XXV.—*On the Saliferous Rocks and Salt Springs of Michigan;* by Alexander Winchell.

The perfectly dish-shaped conformation of the strata of the lower peninsula of Michigan, has prevented the escape to the sea of such soluble substances as were originally embraced in the marine deposits from which the rocks were formed. Were there any point in the margin of one of these rocky basins, lower than its central portions, chance for escape of all its soluble contents would have existed; and it is doubtful whether in such case, brines could have been retained to the present day, in any considerable quantity. Our subterranean peninsular basins are comparable with the superficial basins in which the salt lakes of the world are located. Neither class of basins has an outlet. The basin of lake Superior was once filled with water as salt as that of the Great Salt lake. Both have received accessions of fresh water; but while one has been drained by an efflux which has continually carried away some portions of the chlorid of sodium, the other has been drained only by evaporation. The salineness of one has been reduced almost to an infinitesimal quantity;* that of the other is unimpaired, if it has not

* Given the time required for the efflux through the Straits of St. Mary, of a volume of water equal to the usual contents of Lake Superior; given also the minute percentage of chlorid of sodium still remaining in the water of the lake; it is required to determine how long the processes of dilution through meteorological precipitation and drainage through the Straits must have been continued to reduce the sea-water which originally filled the lake basin to the degree of weakness which it has now attained: disregarding the chlorids derived from the drainage waters flowing into the lake.

actually been strengthened by the loss of more water than it has received.

The subterranean basins of Michigan furnish us with three "great salt lakes." The principal one of these is shown, for the first time, in the "First Biennial Report" of the geology of the State (1860), to occupy a position between the Carboniferous limestone and the sandstones at the base of the Carboniferous system—being on a parallel with the gypsiferous formation of Nova Scotia. It is a mass of argillaceous, gypseous and pyritous shales, with thin beds of arenaceous and magnesian limestone, and beds of pure gypsum from eleven to twenty feet in thickness. The aggregate thickness is from 180 to 200 feet. Its outcrop describes an irregular circle, embracing the central portion of the peninsula. It underlies an area of 17,000 square miles, embracing the whole of 19 counties and at least half of 16 others. This assemblage of strata, though probably included in the American representation of the Mountain Limestone of the Old World, has received the local designation of Michigan Salt Group.

Seven hundred and fifty feet below this is the Onondaga salt group, the circuit of whose outcrop is traced from Monroe county to Galt in Canada West, thence to Mackinac island, Milwaukie and southward. The supply of brine in these strata has not been ascertained. They are well stocked with gypsum and are known to be saliferous.

The third saliferous horizon has but recently been recognized. It was indeed known that brine of feeble strength exists in the coal measures, but only within a few days has it been proved that the salt wells at Bay City and vicinity on the Saganaw river, are supplied from this source. It *might* have been known from the first existence of these wells, if those having the boring in charge could have been induced to preserve specimens of the rocks. The Parma sandstone below the coal measures is the reservoir of this brine, as the Napoleon sandstone beneath the Michigan salt group is the reservoir of the brine from this group. It is now known that the Bay City wells terminated at the bottom of the Parma sandstone though bored to nearly as great a depth as the wells of East Saginaw and vicinity, which pierce the Napoleon sandstone. This fact being established, a new well near Bay City has been sunk to a greater depth, and at 916 feet the Napoleon sandstone has been struck as predicted; and at the depth of 74 feet in this rock, brine has been brought up *completely saturated.* This occurrence, no less than the success of the first well bored in the valley, becomes a very gratifying confirmation of geological inferences drawn from observations extended over thousands of square miles, and in great part, hundreds of miles distant from the points where success has been attained.

When the first geological survey of the state was organized in 1837, Dr. Houghton, the superintendent, was instructed to direct his attention to the development of the "State salt springs." In pursuance of his investigations, and with the liberal coöperation of the legislature, he began, in 1838, two salt wells—one three miles west of Grand Rapids, and the other in Midland county on the Tittabawassee river. The latter, after being prosecuted at intervals for four years, had reached the depth of only 139 feet when the work seems to have been obstructed by a "quartzose" boulder. The Grand Rapids well was sunk 473 feet but without success. In the mean time Hon. Lucius Lyon of Grand Rapids sank a well 661 feet at a point further east; and, obtaining water about one-fifth saturated, succeeded in manufacturing salt for a few years, at a time when salt was selling for $3.00 per barrel.

The cause of these early failures is now apparent. Dr. Houghton entertained erroneous views of the structural geology of the peninsula. He expressed the opinion (Report, 1839, p. 9) that the strike of the rocks was northeast and southwest across the peninsula—that Saginaw bay occupied a denuded space along the outcrop of "the sandstone" just where it comes in contact with "the limestone of the north"—that the coal on the Illinois river was on the strike of the coal-bearing rocks of Michigan—and the galeniferous limestone of Wisconsin and Illinois a prolongation of "a portion of the rock formation in the northern part" of Michigan. He further supposed that the brines of the state rose to the surface through fissures in the strata overlying the salt rock (Rep., 1838, p. 21; also special Rep., 1839, pp. 2 and 3), and that the geological positions of the state wells on the Tittabawassee and Grand Rivers were about the same (Spec. Rep., 1839, p. 6); while the latter was at least 360 feet below the former and separated from it by the whole thickness of the coal measures (see also Hubbard's Geol. Rep., 1841, pp. 132, et seq.).

It now appears that while the well on the Tittabawassee was located far within the salt basin, that on the Grand River was upon the thinning out edges of the strata. The brine at the latter point, as well as in Macomb and Washtenaw counties is caused by a sort of exudation over the rim of this basin, and does not rise through fissures from a deeply seated rock.

When it became apparent that the deepest portion of the great salt basin was probably beneath the neighborhood of the confluence of the Cass, Shiawassee and Tittabawassee rivers, a boring was commenced at East Saginaw, which at 742 feet had passed through the Coal measures, Carboniferous limestone and Napoleon sandstone, and afforded a plentiful supply of brine nine-tenths saturated. This success was the signal for a general onset; and within two years, twenty-three wells have been bored along the valley of the Saginaw, and new ones are continually undertaken.

The following is an average section of the rocks passed through in the borings in the vicinity of east Saginaw:

Alluvial and Drift materials,	100 ft.
"Woodville sandstone," brown and coarse,	65 "
Coal measures, consisting of shales with some sandstones and limestones and coal,	130 "
"Parma sandstone" white and porous,	115 "
Carboniferous limestome, often highly arenaceous; generally so below,	75 "
"Michigan Salt Group,"	170 "
"Napoleon sandstone," light buff, rather coarse and porous,	110 "
Total,	765

The Napoleon sandstone is underlaid by a red shale which has been pierced 64 feet.

From East Saginaw the depth of the wells increases southward, toward the center of the general basin; and also northward, so that in the vicinity of Bay City the bottom of the Napoleon sandstone is found at the depth of 1000 feet. We seem therefore to have a local basin toward the mouth of the Saginaw river, although the vicinity is ten or fifteen miles nearer the outcropping margin of the salt basin, which is found at the mouth of the Pigeon river and in Tawas bay, on opposite shores of Saginaw bay.* This local basin is filled by an extraordinary thickening of the shales of the Coal measures, almost exclusively. As the Parma sandstone, which furnishes the brine of the first wells at Bay City, is probably the equivalent of the saliferous "Conglomerate" of Ohio, it seems that the supply of brine at this horizon, bears a relation to the thickness of the overlying shales of the Coal measures. It also suggests that in the deeper portions of the general basin, the Coal measures must be found similarly augmented in thickness, and the Parma sandstone similarly charged with brine. This condition should be looked for, west and northwest into Gratiot and Midland counties.

The following are analyses of Saginaw valley brines. The first is by Prof. DuBois of the University of Michigan, from the Napoleon sandstone; the second by Jas. R. Chilton & Co., from the Parma sandstone.

* On page 72, vol. i, Geolog. Rep. Wisconsin, Prof. Hall states, undoubtedly through inadvertence, that the "Hamilton group is known upon Saginaw bay." The Hamilton group strikes the lake shores in Thunder and Little Traverse bays many miles further north.

	Saginaw City.	Bay City.
Specific gravity,	1·180	1·163
Chlorid of sodium,	19·246	19·692
" calcium,	2·395	0·742
" magnesium,	1·804	0·432
" potassium,	0·127	
Sulphate of lime,	0·534	0·145
" soda,		0·116
Bromid of magnesium,		0·013
Compounds of iron,	0·064	
Total solid matter,	24·170	21·140

The difference in the composition of these brines is in accordance with their difference of origin.

The average supply of the Saginaw wells is at least 25,000 gallons each, in 24 hours.

The creation of this new branch of local industry is destined to become a matter of very great general importance. Although but two years have elapsed since the production of the first bushel of salt in the Saginaw valley, there are now (Aug. 1st) no less than 22 blocks of kettles in actual operation, turning out 1210 barrels of salt per day, or, making an allowance for the effect of winter weather, 1,980,000 bushels per year. Here is a growth, at the end of two years, equal to that attained by the Onondaga Saltworks in 1834, at the end of 38 years after the salt springs passed under the superintendence of the State. In two months, seven more blocks will come into operation, increasing by nearly one third, the foregoing figures.

Such is the strength and abundance of the brine and cheapness of fuel, that a barrel of salt is made at a cost of 64 cents. The cost of a barrel at Syracuse is at least 95 cents, so that Saginaw salt would pay the manufacturer 48 per cent of profit if the price were put down to the prime cost of the article at Syracuse. Moreover the quality of the article has proved so superior, that the market is actually clamorous for an adequate supply.

When we consider the cheapness and quality of Saginaw salt, the inexhaustibleness of the supply of brine and the excellent facilities for shipment, it would appear that there is little danger of over estimating the future development of this new resource.

University of Michigan, Aug. 4, 1862.

ART. XXVI.—*On the Perception of Relief;* by Prof. EDWIN EMERSON, of the Troy University.

PROF. CIMA, of Turin, has sent us the description (says the editor of the Cosmos) of a stereoscopic experiment which is not without interest. He takes the picture of a front view of a human head, executed either in crayon or lithograph or copper-plate, and which is three or four centimetres in height; this he cuts into two parts along a line which coincides with the vertical axis of the nose; he takes one of these halves in each hand, and holding them in the same perpendicular plane, he brings them before the eyes at a distance which is less than that of distinct vision; he then allows the optic axes to converge, and thus causes the drawings to approach or recede until he is able to see two pictures of each half, and until the two middle ones overlap, so that they make the impression of an entire countenance. When one makes this experiment for the first time, says Prof. Cima, he will see with astonishment that the full face which is produced by the overlapping of the two halves makes, in a high degree, the impression of a solid body; the half tones melt and mix together as in a modelled figure; the nose rises well from the face; the eyebrows, lips and chin stand out very well; and the entire figure raises itself from the ground upon which it is drawn, and assumes, in a remarkable degree, a living expression. The necessary distance of the two half-pictures from each other and also the proper distance from the eyes of the observer for the production of the greatest effect, can only be ascertained by trial. The more steadily one gazes at the pictures, the more the sensation of relief is strengthened."*

The foregoing extract from *The Cosmos* has been reproduced in *Pogg. Annalen*, bd. cii, p. 319; in *Il Nuovo Cimento*, vi, 185; in *Die Theorie des Schens und räumlichhen Vorstellen*, bei Dr. Cornelius, Halle, 1861; and in *Monographie du Stéréoscope*, par Blanchère, Paris, 1862. Seemingly endorsed by such a high authority as Moigno, the alleged fact passes through scientific treatises unquestioned, and is now apparently regarded as established. We consider it, therefore, important to refute the conclusions involved in the experiment as described by Prof. Cima, and at the same time point out some analogous mistakes as to the perception of relief.

When the experiment of Prof. Cima is carefully performed and analyzed it will be found that the right eye sees the right half of the middle picture, and the left eye the left half, now as these two dissimilar masses are not superposed upon each other, as is the case with the dissimilar complementary figures in ordi-

* Cosmos, pp. 353, vol. ii.

nary vision, but are merely joined together at the line passing through the centre of the resultant picture, it is evident that if such an effect is realized as that "the nose rises well from the face" or that there is any "sensation of relief," we have here an experiment which refutes the established theory of binocular vision, and leaves the effects of the stereoscope without any adequate explanation.

The fact is, however, that in Prof. Cima's experiment there is no real perception of relief. All that is really seen is the perspective, which is mistaken for relief or solidity. To prove this —let the observer, while looking at the two half-pictures in the mode alledged to produce the effect of solidity, close one eye, the right for instance, the right half of the picture disappears, but the left retains exactly the same appearance it had before; it loses no appearance of solidity simply because it had none. Or, let the observer join the two halves together and closely and continuously observe them with one eye, the effect will be the same as in Prof. Cima's experiment. Or, to vary the test, take a *single* photographic picture, for instance the right hand side of a stereograph, cut it in two by a vertical line through the centre and place the halves the proper distance apart in a stereoscope, so as to unite them readily into a whole, the same effect, claimed by Prof. C. to be a sensation of relief will be observed: that it is not relief will be most manifest by comparing it with a stereograph of the same scene.

But the reader will very naturally inquire—'How did Prof. Cima, and those who have unquestioningly quoted his experiment fall into this error with regard to the presence of relief?' This reasonable question we will endeavor now to answer.

The ability to perceive relief, or solidity, is a natural one. To those who have the proper use of their eyes, and can walk, it is an intuitive faculty, we cannot help seeing solidity, where it exists, if we try, no more than we can help hearing sounds or seeing colors. The common idea that this faculty is the *result* of experience and is, therefore, acquired, is opposed by the whole analogy of our being. The infant does not learn to hear; it hears, it hears intuitively, if it is a perfect child, but learns as it grows to know what it hears; it feels a blow but may be too young and feeble to know what that blow is; so it has but to open its eyes and the scene enters, it is painted properly and instantaneously upon the retina, but it may require a long education before the child will have an intelligent idea of what it sees; indeed it may go through life and never be able to give more than *one* name to a great variety of very different colors, such as red, vermillion, scarlet, orange and crimson. It is unphilosophical to confound a faculty with its use. We have the natural faculty of seeing solidity; but the acuteness with which it is employed, depends greatly upon the intelligent attention with which it is exercised.

It is no answer to this to say that we can analyze the optical conditions upon which the perception of relief depends. This has been splendidly done by Wheatstone, Dove, and others, and is beautifully illustrated by the stereoscope; but this has no necessary connection with the question before us. When I say—we hear intuitively—it is nothing, in the way of refutation, to explain to me the acoustic conditions upon which hearing depends, or to assert that Mozart had no intuitive perception of melody or harmony because the laws are fixed by which a melody ought to proceed, and harmony, to be such, must be according to the formula of Thorough Base, whereas the child Mozart could not know all this. So with the matter in question; all men see solidity who have the proper use of their eyes; very few indeed know how it is effected, or are able to distinguish acutely between the perception of binocular relief and the perception of mere perspective, or the appearance of distance without relief.

The perception of *relief* depends upon the angle formed by the rays which proceed from any object of sight to the right and left eyes respectively; the larger this angle the more relief is apparent, provided the eyes can unite the dissimilar images; but when by reason of distance this angle becomes nothing, practically, and the rays are parallel as they enter the eyes, relief vanishes.

The perception of the *perspective* depends upon very different conditions, such as the direction of the lines that compose a view, the light and shade, the apparent size, the tint, &c.

When we consider the matter it is not surprising that these two modes of perception should often be confounded. True relief diminishes so gradually, and melts so gently away, leaving perspective entirely master of the field, that the essential difference between them is likely to be lost sight of. That this is the case may be shown by the following examples:—

It requires a series of very careful experiments to determine how far, under ordinary conditions, we can perceive relief. Experiments of my own lead me to believe that the distance is under three hundred yards. The only reason a good painting, whose foreground is represented as it appears at the distance of two or three hundred yards, is not a complete illusion when seen under favorable conditions, is, that we can change our point of view; and motion to one side or the other will impart the idea of relief in nature, but as there is no relief, properly so-called, in a painting, as soon as we shift the point of view, we detect this and the illusion is at an end. Hence, paintings ought to be observed by one eye, and from one point of view to obtain the maximum effect. Hence, also, stereographs of scenes which lie at a distance of over three hundred yards from the observer will give no stereoscopic effect, will not *give the impression* we are able to get with our eyes, assisted by our capacity to move from one point of view to another; they ought, therefore, to be photographed from stations more or less distant from each other, but always exceeding considerably the distance between the eyes.

Persons *not accustomed* to experimenting with the stereoscope cannot distinguish readily between stereoscopic and pseudoscopic effect; they are also constantly imposed upon by views which have no stereoscopic effect whatever; I have repeatedly mounted two identical or right-eye views of the same scene, side by side, as though they were right and left eye views and have never failed to get the verdict that they exhibited stereoscopic effect; which was impossible, of course. Not only are ordinary observers thus mistaken, but they constantly manifest an opposite peculiarity, being unable to see the greatest relief when it is exhibited in an unusual manner. In *Das Stereoscop*, C. G. Ruete, Leipsig, 1860, Dove's illustration of this point is republished in such a way as to destroy the object in view, showing that his commentator had not a fine perception of relief.

A remarkable instance of the uncertainty attending the perception or non-perception of stereoscopic relief, even in cases where we might suppose there could be no want of knowledge is shown by the controversy now going on in Europe over *The Chimenti pictures.* Sir David Brewster thinks he has in these pictures a specimen of real stereoscopic drawings produced about the middle of the 17th century; and this opinion is endorsed by Prof. Tait, Prof. M'Donald and others in decided terms. I have made a careful examination of the photographs of these pictures, and the truth is that the trifling stereoscopic and pseudoscophic qualities about them are evidently accidental. To prove this let any one execute a pen-and-ink sketch; and then let him make as perfect a copy of it as he can without careful measurements; now place these two drawings in the stereoscope and you get the same kind of effect seen in the Chimenti drawings, and for the same reason; the drawings will vary more or less from each other; all that is necessary then to impose upon ordinary eyes, is to find out which way the sum of the variations preponderates; mount the drawings accordingly, and, mirabile dictu! you have produced a stereoscopic picture (the pseudoscopic portion being overlooked) drawn by hand; you have done that very thing that Sir David Brewster has repeatedly declared was quite beyond human skill! If Prof. Wheatstone gets no heavier blow than this, his fame as a discoverer is secure.

As a further confirmation of our views, we may point to the fact that but few persons can properly locate the optical position of reflections from curved surfaces, and, in particular, the images from concave surfaces.

During the last year or two large assemblages have been drawn together in our principal cities, to see with delight the effects produced by what is called *the Stereopticon*, which is merely another name for a Magic-lantern of good quality, with *one* side of a glass stereograph for a slide. Nearly all in these large assemblages have agreed in believing that they saw, what they were told they saw, excellent stereoscopic effect in the single picture which alone is exhibited. The truth is they made the popular mistake; they saw nothing but perspective.

Stereoscopic effect on a large scale may be obtained by exhibiting the right and left pictures of a glass view side by side, by the magic-lantern, and then uniting the magnified pictures by means of prisms. This I have recently demonstrated by experiment. The idea was also suggested some years ago, by Dr. Wolcott Gibbs to Mr. Pike, of New York, but not put to the test.

We conclude, then, from the foregoing—

1. That Prof. Cima's experiment is only another instance showing how easily we can mistake one thing for another, and induce others to do the same.

2. That intuitive perception of relief may be indefinitely increased in degree by exercise; showing that this sense follows the same law under which we employ our other faculties.

Art. XXVII.—*On the relations of Death to Life in Nature;* by J. D. Dana.*

1. The creation of a plant with "seed in itself," as Moses states in his concise description, was the simultaneous institution of life and death. It was the establishment of an incoming and outgoing stream, to be in constant flow as long as the kingdoms of life should last—an incessant renewal of youth, and rejection of age.

All life is a system of progressing change in cycles—the germ first, then the embryo, the young, the adult, and last, the seed or germ again, to continue the rounds; the adult sooner or

* From a paper on the Anticipation of Man in Nature, published in the New Englander, for May, 1859. Views similar to those here given on stored force in plants were presented to the American Association in Aug., 1859, by Prof. Joseph LeConte, and published in this Journal for Nov. of that year, vol. xxviii, p. 305. As Prof. Dana's paper is prior in date, he will not be charged with copying the views (which we doubt not were independent,) of Prof. LeConte. The paper of Prof. Henry, in vol. xxx, p. 32, also contains some views bearing on the subject. This paper is here republished, not because of any novelty in the thoughts, since they are in the main well understood among scientific men, but from a desire to spread a knowledge of the relations of death to life beyond the pale of science.—Eds.

later disappearing from the field of progress, and then from the sphere of existence. Death is implied in the very inception of the scheme.

2. Death is also in every step of the process of life. For the living being is throwing off effete matter during all its growth; the change is constant, so that with each year a large part of the material in our bodies has passed away and been replaced by new. Moreover, the force which had been expended in making a cell, or particle of tissue, goes to form a new cell or particle when the former dies, and was needed for the new formation going on. Force is not lost or wasted, but used again. There is unceasing flow, and in this flow is life; its cessation is death.

3. The kingdom of plants was instituted to turn mineral matter into organic, that the higher kingdom of animals might thereby have the means of sustenance; for no animal can live on mineral matter. Now this living of animals on plants implies the death of plants.

Again, the rocks of the globe are, to a great extent, made of the remains of dead animals.

4. The chemistry of life, also, required death. Life in the plant or animal if sustained by means of nutriment, and continued consuming, with no compensating system, would evidently end in an exhaustion of any finite supply. A perfect adjustment was therefore necessary, by which nutriment should sustain life, and life contribute to nutriment. Now the plant takes up carbonic acid from the atmosphere, appropriates the carbon, and gives back the oxygen. Yet there is no tendency to an exhaustion of the atmospheric carbonic acid, or an over-supply of the oxygen; for death strikes an exact balance.

The death of the plant ends in a change of all its carbon into carbonic acid again. Thus the plant, as it grows, decomposes carbonic acid to get carbon, and then ends in making, by its decay, as much carbonic acid, and restoring it to the atmosphere. Thus, through death the compensation is perfect. The atmosphere loses only what it receives. Again, as just now observed, the plant, in growing, gives oxygen to the atmosphere; but in the decay of the plant, the carbonic acid formed is made by taking up the same amount of oxygen. The same carbon that lost oxygen when becoming a part of the plant, takes it again at the decay. The system is hence complete. The parts play into one another in perpetual interchange. Take death and decay out of the sytem, and it would not work.*

* In early geological history, as is generally believed among geologists, there was an excess of carbonic acid in the atmosphere; and this excess was removed to a great extent, by the growth of plants during the Carboniferous era. Vegetable material decaying under water does not undergo complete decomposition, and thus part of

Animal life, as above stated, was made to subsist on plants. But the scheme is so well managed as not to disturb the balance made by the vegetable kingdom alone. For all the carbon of animals comes from plants. The plants which feed an animal, and which, on decay, would have turned into carbonic acid, become changed into carbonic acid in the course of the growth of the animal, so that the whole amount of carbonic acid which the animal makes, is only what the plants would have made if left to natural decay. Thus the higher kingdom of life is introduced and sustained, and yet the balance remains undisturbed. The system is perfect.

5. Again, one part of the animal kingdom, through every class, is made to eat up the other part, or at least live on it. The flesh-eaters are of all grades, low and high, from the infusorium and maggot, to the lion and man. Some take what is already dead or decomposing; others kill and eat. On this subject we observe:

(1.) Death is in the system of nature—death from earthquake, lightning, and all moving forces, as well as by natural decay; and the creation of carnivorous animals was hence in harmony with the system.

(2.) Various noxious animals are held in check by the carnivorous species.

(3.) By means of flesh-eaters, the diversity of animal species subsisting on a given amount of vegetation is vastly increased, and a wider expansion is given to the animal kingdom.

(4.) Putrefaction of the dead is prevented by a multitude of scavengers. who at the same time turn the flesh into food for the vegetable kingdom; and thus plants feed animals, and animals feed plants,—one of nature's circles again.

The last two principles mentioned are of profound importance. The vegetable kingdom is a provision for the storing away or magazining of force for the animal kingdom. This force is acquired through the sun's influence or forces acting on the plant, and so promoting growth; mineral matter is thereby carried up to a higher grade of composition, that of starch, vegetable fibre and sugar, and this is a state of concentrated or accumulated force. To this stored force animals go, in order to carry forward their development; and moreover, the grade of composition thus rises still higher, to muscle and nerve, (which contain nitrogen in addition to the constituents of the plant,) and this is a magazining of force in a still more concentrated or condensed state.

the carbon is left behind; and so far as there is carbon left, there is an actual abstraction of carbonic acid from the atmosphere, by the process of growth. The Coal-era was a period of great marshes; and by this means the needed purification of the atmosphere was effected, preparing it for land life. The amount abstracted now by the same means is very small, and may be balanced by the carbonic acid from mineral sources and volcanoes.

There are thus five states of stored force in nature—three in the *inorganic*, the solid, liquid, and gaseous; and two in the *organic*, the vegetable and animal.

Now what is the provision to meet this last and highest condition? Is this magazined force left to go wholly to waste by the death and decomposition of the plant-eaters? Just the contrary: an extensive system of flesh-eaters was instituted which should live upon it, and continue it in action in sustaining animal life among successive tribes. The flow is taken at its height, and the power is employed again and again, and made gradually to ebb. What is left as the refuse is inorganic matter—the excreted carbonic acid, water, and excrements, with bones or any stony secretions present. Thus the flow starts at the inorganic kingdom, and returns again to the inorganic. Moreover, in the class of quadrupeds, (mammals,) the flesh of the herbivores (cattle) is among the means by which the animal type is borne to the higher grade of the carnivores. The true carnivores, besides, take the best of meat. Whales may live on the inferior animals of the sea; but the large forest flesh-eaters take beef and the like.

There is another admirable point in this scheme. The death and decomposition of plant-eaters would have rendered the waters and air, locally at least, destructive to life. It is well known that it is necessary in an aquarium to have flesh-eaters along with the plant-eaters and plants. And when in this way the living species are well balanced, the water will remain pure, and the animals live on indefinitely. If not so balanced, if an animal is left to decay, the waters become foul, and often everything dies. Putrefaction and noxious chemical combinations follow death, because, in life, the constituents, carbon, hydrogen, nitrogen, and oxygen, are in a constrained state, at the furthest remove from what chemical forces alone can produce; and hence, when the restraint is taken off at death, the elements fly into new conditions according to their affinities. Now animals, dying yearly by myriads, are met at death by an arrangement which makes the dead contribute anew to animal life as its aliment, and in this very procees the flesh ultimately comes out innocuous, and is at last so far changed to the inorganic condition as to be the best of fertilizers for plants. Part of the process of getting rid of the great fleshy carcasses, consists in their minute subdivision by the feeding of larves of insects, and, further, an infinitesimal division of the insect as the food of the infusoria,—which again may become the nutriment of larger animals, to go the rounds once more. But the final result is, as stated, *plant-food*—largely through the processes of digestion and excretion, but part through the decomposition of animals that are too small and readily dried up to prove offensive.

Thus the carnivorous tribes were necessary to make the system of life perfect.

One word respecting the necessity of a check on the excessive multiplication of individuals. Nature, as just now observed, is a system of constantly varying conditions—of changing seasons, winds, clouds: of inconstancy, under law, in all forces and circumstances. At the same time, the growth of a species requires the nicest adjustment of special conditions in each case. On this account the reproductive powers in species is in many cases excessively large, so that the various accidents to which the eggs or young would be exposed, might not cause their extermination. This provision opened the way for occasional excessive multiplication, and required a check from carnivorous races.

6. Finally, could death be prevented in a system of living beings in nature without constant miracle? How should the earth be managed to secure it against death? It would be necessary to still the waves, for they are throwing animals and plants on the coast to die; to still the winds, for they are ever destroying in some parts of their course; to still even the streams and rains. With winds and waves, not only helpless animals and plants, but men's houses, ships, and boats, would now and then be destroyed, in spite of prudent precaution and holy living. But if we still the waves, the winds, and the streams, the earth would rot in the stagnation, and here again is death!

We thus learn, that in life the fundamental idea of reproduction implies death; the processes of life are the processes simultaneously of death; the stability of the system of life requires death; the vegetable kingdom is made to feed animals, and the animal kingdom, while containing plant-eaters, demands flesh-eaters for its own balance, for the removal of the dead, and to make out of dead flesh the proper food for plants, thus to pay its debt to the vegetable kingdom. Hence death pervades the whole system of life in its essence and physical laws; and it could not be prevented in a world of active forces except by a constant miracle; and this would be an annihilation of nature, that is, of a system of law.

ART. XXVIII.—*On the Carbonates of Alumina, Glucina and the sesquioxyds of Iron, Chromium and Uranium;* by THEODORE PARKMAN, Ph.D.

THE precipitates, produced by the alkaline carbonates in solutions of alumina, glucina and the sesquioxyds of iron, chromium and uranium, have been investigated by a large number of observers; but their results are so discordant, that the true composition of the substances in question is still in doubt. The following investigation was undertaken at the suggestion of Prof. Charles W. Eliot, under the idea that the contradictory results, obtained by previous writers, may have been owing to a loss of carbonic acid, during the processes of washing and drying. This would be probable enough in itself, from the weak affinities of both acid and base, in each case, and is, I think, fully confirmed by the analyses which follow.

1. *Carbonate of the sesquioxyd of iron.*

Fe_2O_3, CO_2.

The precipitate, formed by mixing carbonate of potash with nitrate of the sesquioxyd of iron, after washing with cold water, consists, according to Gmelin,* of hydrated sesquioxyd of iron, free from carbonic acid. Berzelius† considers that the compound $Fe_2O_3, 3CO_2$ is formed, but that it exists only momentarily. Langlois‡ gives an analysis of a precipitate, produced by carbonated alkali in a sesqui-salt of iron, perfectly freed from alkali by washing and dried at 100° C. His results were 88·47 p. c. Fe_2O_3, 10·17 HO, 1·36 CO_2, from which he does not deduce any formula. Wallace§ finds the precipitate by carbonate of soda in sesquichlorid of iron, after drying over sulphuric acid, to be $3Fe_2O_3, CO_2, 6HO$: in the nitrate, $9Fe_2O_3, CO_2, 12HO$. According to Barratt,‖ the precipitate produced by carbonate of soda in sesquichlorid of iron, when dried in the air, has the formula $3Fe_2O_3, CO_2+8HO$; when dried at 100°, $3Fe_2O_3, CO_2+4HO$.

The carbonate of iron which I have examined was precipitated, at the ordinary temperature, from pure crystallized iron-potash-alum by carbonate of soda in slight excess. The precipitate was not washed or dried, but simply pressed between folds of porous paper, under a heavy weight, for about twelve hours, and while still moist, introduced into a bulbed tube of hard glass, and the whole weighed. It was then ignited in a slow stream of

* Handbook of Chem., v, 222.
† Lehrb. der Chem., iii, 626.
‡ Ann. Chim. et Phys., xlviii, 502.
§ Chem. Gaz., 1858, 410, in Jahresb., 1858, 70.
‖ Chem. News, i, 110, in J. pr. Chem., lxxxii, 61.

dry air and the water caught by a weighed chlorid of calcium tube. The loss of weight in the bulbed tube and substance, minus the increase of weight in the chlorid of calcium tube, would give the weight of carbonic acid corresponding to the carbonate of iron, while the carbonate of soda and sulphate of soda would remain unchanged. The sesquioxyd of iron, remaining in the bulb, was washed and weighed. Of course, by this method, the water cannot be estimated, which, according to all previous observers, exists in all the carbonates in question. In my first analyses the substances, though not washed, were dried over sulphuric acid: but three analyses of the same substance, which gave successively the percentages of carbonic acid, 15·74, 14·45 and 12·95, showed conclusively that the substance lost carbonic acid by standing. All the other analyses made, both of this and of the other carbonates, were therefore made with the precipitate, while still moist. The formulas obtained, therefore, express simply the relation between the acid and the base, and a certain amount of water must probably in every case be understood. In every case, more than one preparation was analyzed, to ascertain whether the precipitate had always the same composition.

Of the carbonate of iron four analyses were made, with the following results:

	Calculated.		Preparation I.	Prep. II.	Prep. III. 1.	Prep. III. 2.
Fe_2O_3	80	78·43	79·88	79·47	79·09	80·52
CO_2	22	21·57	20·12	20·53	20·91	19·48
	102	100·00	100·00	100·00	100·00	100·00

Considering the ease with which the substance loses carbonic acid, the above results agree with the calculated percentage probably as closely as could be expected—closely enough, at any rate, to fix the composition of the substance with sufficient certainty.

2. *Carbonates of the sesquioxyd of chromium.*

$Cr_2O_3, 2CO_2$

Cr_2O_3, CO_2

The earliest analysis of carbonate of chromium is by Meissner,* who found it to contain 77·30 Cr_2O_3, 15·54 CO_2 and 7·16 HO. Meissner's analysis, however, is quite untrustworthy, as may be seen from his details of it. According to Lefort† the precipitate by carbonated alkalies in the violet salts of chromium is Cr_2O_3, CO_2+4HO; in the green modification only the hydrated oxyd. According to Langlois,‡ the precipitate by carbonated alkalies in the salts of chromium, dried at 100° C., is Cr_2O_3, $CO_2+Cr_2O_3$, 6HO. Wallace§ precipitates sesquichlorid of chromium by car-

* Gilbert's Annalen der Physik, lx, 366.
† Compt. Rend., xxvii, 269.
‡ Ann. Chim. et Phys., [3] xlviii, 502.
§ Chem. Gaz., 1858, 410, in Jahresb., 1858, 70.

bonate of soda, in very dilute solution, and dries the precipitate over sulphuric acid. His results give the formula Cr_2O_3, CO_2, 4HO. Barratt* proceeds in the same way as Wallace and obtains the same result, which is also that obtained by Lefort.

The substance which I analyzed was precipitated by carbonate of soda, in slight excess, from crystallized chrome-potash-alum, free from iron and alumina. In the first analysis, given below, the substance was dried over sulphuric acid: in the others not. The first analysis was made like those of carbonate of iron. The wash-water from the oxyd of chromium, left in the bulbed tube after ignition, was colored yellow from alkaline chromate. This must have arisen from oxydation of a little oxyd of chromium, by ignition in the air in contact with alkaline carbonate. The solution was reduced by hydrochloric acid and alcohol, precipitated by ammonia, and the oxyd of chromium thus obtained added to the rest. There still remained an error, however, from the chromic acid having driven out carbonic acid from the carbonate of soda; and to avoid this, the other determinations were made in a stream of hydrogen. In this latter method there would be a possible source of error, viz., a reduction of the alkaline sulphate to sulphid. This, however, was extremely small, as the wash-water, on heating it with hydrochloric acid, gave off in every case only a trace of sulphuretted hydrogen and either remained clear, or became only very slightly milky, from precipitated sulphur.

The analyses of a large number of preparations gave the following results:

	Calculated.		Prep. I.	Prep. II. 1.	Prep. II. 2.	Prep. III. 1.	Prep. III. 2.	Prep. IV. 1.	Prep. IV. 2.	Prep. V. 1.	Prep. V. 2.
Cr_2O_3	77·4	63·76	66·81	66·51	66·89	67·53	66·59	73·03	73·44	72·55	73·84
$2CO_2$	44·	36·24	33·19	33·49	33·11	32·47	33·41	26·97	26·56	27·45	26·16
	121·4	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00

The composition of the first three precipitations comes pretty near the formula, given above, while the other two vary largely from it. These two were made in summer, while the others were made in cold weather, and it is possible that there may have been a greater loss of carbonic acid at the higher temperature. I am inclined to think, however, that this is not the case, as, in the last preparation, the liquids were cooled, before precipitation, and the precipitate left to press in a refrigerator, containing ice. It occurred to me that one cause of the varying composition of the precipitates might be that basic compounds might at first go down, before the carbonate of soda was in excess, as is the case, for example, when ammonia, not in excess, is added to solutions of copper. To ascertain whether this was the case, an analysis was made of a precipitate, produced by pouring chrome

* Chem. News, i, 110, in J. pr. Chem., 82, 61.

alum slowly into carbonate of soda, with constant agitation, until the alkaline reaction became comparatively feeble. In this way there would be always an excess of carbonate of soda present. Two analyses were made of the same preparation.

	Calculated from Cr_2O_3, $2CO_2$.	I.	II.
Cr_2O_3.	63·76	65·03	64·96
$2CO_2$.	36·24	34·97	35·04
	100·00	100·00	100·00

This seems to prove pretty conclusively that there is a carbonate of chromium, possessing the above formula, and that the precipitate produced by the alkaline carbonates consists chiefly of it, generally mixed, however, with variable quantities of a more basic compound. This latter may very probably be a carbonate of chromium, which will be described further on.

As already mentioned, Lefort asserts that the precipitate, produced by the alkaline carbonates in solutions of the green modification of sesquioxyd of chromium, is hydrated oxyd, containing no carbonic acid. The following is the result of an analysis, made by myself, of such a precipitate. The chromium solution used was prepared by boiling the violet chrome-alum for about an hour, and cooling the solution before precipitation. The percentages obtained were 59·38 Cr_2O_3 and 40·62 CO_2. The carbonic acid is probably too high, and I regret that I did not have time to repeat the analysis. It is, however, sufficient to show that the substance contains carbonic acid, and that its composition is probably the same as that of the precipitate obtained in the violet modification.

The agreement of the results of Lefort, Wallace and Barratt, who all make the carbonate of chromium to be Cr_2O_3, CO_2+4HO, makes it probable that the bicarbonate, above described, loses its second atom of carbonic acid more readily than the other and is converted by washing and drying into a more stable monocarbonate. This latter is also formed, when a boiling solution of chrome alum is precipitated by carbonate of soda, as is shown by the following analysis of a precipitate thus prepared:

	Calculated.		Found.
Cr_2O_3	77·4	77·86	78·68
CO_2	22·	22·14	21·32
	99·4	100·00	100·00

3. *Carbonate of Alumina.*

Saussure* considers the precipitate, produced by alkaline carbonates in the solutions of alumina, to be a compound of alumina with a little alkaline carbonate. Muspratt† finds that the precipitate by carbonate of ammonia in alum is $3Al_2O_3$, $2CO_2$+16HO.

* Jour. Phys., lii, 290. † Chem. Soc., Qu. J., ii, 216.

Muspratt does not mention whether he tested the substance for ammonia, which it should contain, according to H. Rose,* who finds that the precipitate, after being washed, first with hot and then with cold water, has the composition, $Al_2O_3, 3HO+NH_4O, 2CO_2+HO$. Langlois† finds the precipitate by alkaline carbonates in the salts of alumina to be $3(Al_2O_3, CO_2)+5(Al_2O_3, 8HO)$. Wallace‡ precipitates the chlorid by carbonate of soda, in very dilute solution, and dries the precipitate over sulphuric acid. He gives the formula, $3Al_2O_3, 2CO_2, 9HO$. Bley§ obtains percentages of carbonic acid varying from 5·27 to 11·39, in the precipitate, produced by alkaline carbonates in solutions of alum, and considers it to be a mere mixture, of variable composition. Barratt‖ finds that the precipitate by carbonate of soda in chlorid of aluminum, after washing, drying, rubbing with water and again washing and drying over sulphuric acid, consists of alumina, free from carbonic acid.

The precipitates, which I have examined, were precipitated by carbonate of soda, in slight excess, from alumina-potash-alum, free from iron. The mode of analysis, used in the iron and chromium compounds, was not applicable in this case. The strongly alkaline wash-water, from the ignited alumina, contained alumina in large quantity, showing that aluminate of soda had been formed and carbonic acid, therefore, driven out of the carbonate of soda. Attempts to overcome this difficulty, by taking weighed quantities of alum and carbonate of soda, in equivalent proportions, and by exactly neutralizing the solution of alum by carbonate of soda, did not give good results. The method finally adopted was to wash the substance with water saturated with carbonic acid, until a portion of the filtrate, after being boiled to expel carbonic acid, gave no alkaline reaction. This would probably give correct results, since the water, being already saturated with carbonic acid, would hardly wash out any from the substance. The latter, moreover, would hardly absorb any more carbonic acid from the water, since, during the precipitation, free carbonic acid is given off in great quantity and the alumina must have combined with as much carbonic acid as it would be possible for it to take up. In other respects, the analyses were conducted like those of the carbonate of iron. The following are the results obtained:

	Prep. I.		Prep. II.	Prep. III.		Prep. IV.	
	1.	2.	1.		2.	1.	2.
Al_2O_3	79·13	79·32	75·95	81·37	81·91	77·51	76·72
CO_2	20·87	20·68	24·05	18·63	18·09	22·49	23·28
	100·00	100·00	100·00	100·00	100·00	100·00	100·00

* Pogg. Ann., xcii, 452.

† Ann. Chim. et Phys, [3] xlviii, 502.

‡ Chem. Gaz., 1858, 410, in Jahresb., 1858, 70.

§ J. pr. Chem., xxxix, 1.

‖ Chem. News, i, 110, in J. pr. Chem., lxxxii, 61.

Preparation I. was analyzed in April: Preps. II. and III. in summer: Prep. IV. also in summer; but, to avoid a possible loss of carbonic acid in hot weather, it was precipitated from cooled solutions of alum and carbonate of soda, washed with ice-water saturated with carbonic acid, and pressed in a refrigerator. The variable composition of the substance led me to suppose that it was a mixture of more than one substance, and, for the same reasons as in the case of the carbonate of chromium, led me to make the following analyses of precipitates, produced by pouring alum into carbonate of soda, until the alkaline reaction became weak. Both were prepared in hot weather, but with the precautions above mentioned.

	Calculated.		Prep. I. 1.	Prep. I. 2.	Prep. II. 1.	Prep. II. 2.
Al_2O_3	51·4	70·03	70·44	71·06	77·79	77·02
CO_2	22·	29·97	29·56	28·94	22·21	22·98
	73·4	100·00	100·00	100·00	100·00	100·00

The composition of the first preparation comes pretty near the formula, while that of the second is very much like that of the substances, precipitated in the other way. Possibly in this last precipitate, the alum may have been poured in too rapidly, without agitation of the liquid, and thus caused, at the point where it fell, temporary excess of alum, thus affording the same probable cause for error as in the other mode of precipitation. The above results lead to this, I think, as the most probable conclusion: viz., that the normal carbonate of alumina possesses the composition Al_2O_3, CO_2, analogous to that of the carbonates of iron and glucina and one of the carbonates of chromium; and that the precipitate, produced by the alkaline carbonates in solutions of alumina, consists chiefly of this normal carbonate, generally mixed, however, with more or less of a more basic salt or of hydrate of alumina.

4. *Carbonate of Glucina.*

G_2O_3, CO_2.

Schaffgotsch* gives an analysis of a carbonate of glucina, precipitated by boiling a solution of glucina in carbonate of ammonia. He finds the percentages, 47·53 G_2O_3, 17·57 CO_2 and 34·90 HO, corresponding most nearly to the formula, $3G_2O_3$, $2CO_2+9HO$. Weeren† gives analyses of precipitates, obtained by boiling solutions of glucina in carbonate of ammonia, under somewhat different circumstances, and obtains the formulas, $4G_2O_3+4CO_2+11HO$: $3G_2O_3+2CO_2+10HO$: $7G_2O_3+3CO_2+14HO$. For a precipitate by carbonate of ammonia, not in excess, from a neutral solution of glucina in hydrochloric acid, he obtains the formula, $11G_2O_3+6CO_2+26HO$.

* Pogg. Ann., l, 83.

† Pogg. Ann., xc, 91.

The salt of glucina, which I used, was prepared by dissolving glucina in a slight excess of sulphuric acid and washing out the excess of acid with alcohol. The glucina used had been freed from alumina and iron, by dissolving it in sesquicarbonate of ammonia and precipitating it by boiling, and by again dissolving it in caustic soda and precipitating it by boiling. From the sulphate, thus obtained, the carbonate was precipitated by carbonate of soda, in slight excess, and analyzed in the same way as the carbonate of iron. The wash-water from the ignited glucina contained no glucina, no glucinate of soda having been formed. Analyses of two preparations gave the following results:

	Calculated.		Prep. I. 1.	Prep. I. 2.	Prep. II.
G_2O_3	38·	63·34	63·31	63·57	63·52
CO_2	22·	36·66	36·69	36·43	36·48
	60	100·00	100·00	100·00	100·00

If glucina be regarded as a protoxyd, as it has been by some chemists, the above results would correspond to the formula, $3GO, CO_2$ (calculated, G.=4·7, 63·40 GO and 36·60 CO_2).

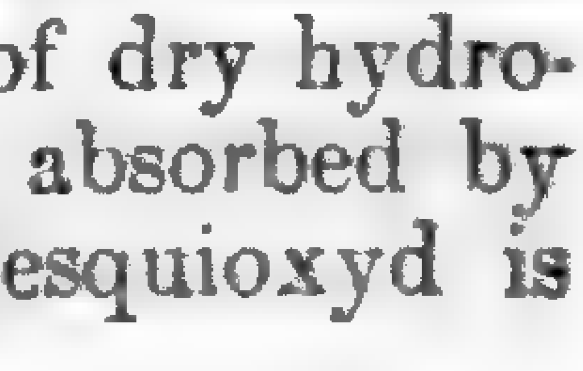
5. *Carbonate of the sesquioxyd of Uranium.*

The precipitate, produced by carbonate of potash in nitrate of uranium, after being washed with cold water and dried in the air, has, according to Ebelmen,* the following composition: 3·66 KO, 3·87 CO_2, 81·98 U_2O_3 and 10·49 HO; and is probably a mere mixture.

The precipitates, which I have examined, were precipitated, some from the sulphate, others from the nitrate of uranium, by carbonate of soda, in as small excess as possible. The general mode of analysis, described under carbonate of iron, could not be employed here. There would be a variable mixture left in the bulbed tube, after ignition, consisting partly of uranate of soda (formed when sesquioxyd of uranium is ignited with carbonate of soda) and partly of proto-sesquioxyd of uranium. The substance was, therefore, ignited in a stream of dry hydrogen, free from carbonic acid, and the carbonic acid absorbed by a weighed soda-lime tube.† In this way, the sesquioxyd is

* N. Ann. Chim. Phys., v, 189.

† This method of absorbing carbonic acid by soda-lime, seems to work very well. In one case, a tube, used for the fourth time, still absorbed the carbonic acid perfectly, as was shown by a tube, containing pieces of solid caustic potash, attached to it, not increasing in weight. The originator of the method uses, instead of a chlorid of calcium tube, a U tube, containing pumice soaked in sulphuric acid, and having a little sulphuric acid at the bottom, to show the rate at which the gas is passing through. In my analyses, I used a chlorid of calcium tube, as usual, and to show the rapidity of the stream of gas, I employed a little bulb-apparatus, of the annexed form, passing through the cork at one end of the soda-lime tube, and filled with caustic potash. This has the advantage that it absorbs a large part of the carbonic acid and thus makes the soda lime last longer.



reduced to protoxyd, which does not drive out carbonic acid from carbonate of soda. The residue in the bulb was washed somewhat, ignited, evaporated to dryness with hydrochloric acid and chlorid of ammonium, and ignited in a stream of hydrogen. After thorough washing, it was again ignited in hydrogen and weighed as UO. This process is, according to Rose,* the best method for separating uranium from the alkalies.

The three following analyses were of precipitates from the nitrate. The first two were dried: the last was not.

	Calculated.		Prep. I. 1.	Prep. I. 2.	Prep. II.
$3U_2O_3$	432	90·76	91·60	90·29	90·55
$2CO_2$	44	9·24	8·40	9·71	9·45
	476	100·00	100·00	100·00	100·00

The five next analyses were of precipitates from the sulphate. The last was precipitated by pouring the sulphate of uranium into the carbonate of soda: the others, as usual, by pouring the carbonate of soda into the uranium solution.

	Calculated.		Prep. I. 1.	Prep. I. 2.	Prep. II. 1.	Prep. II. 2.	Prep. III.
$3U_2O_3$.	432	95·16	95·52	94·60	94·13	94·68	94·54
CO_2.	22	4·84	4·48	5·40	5·87	5·32	5·46
	454	100·00	100·00	100·00	100·00	100·00	100·00

Notwithstanding the tolerably close agreement of the above results with the formulas just given, I am strongly inclined to think that these formulas do not express the true composition of the precipitates. A portion of one of the precipitates, after very protracted washing with cold water, still contained alkali, showing the presence of uranate of soda.† This result might indeed be inferred, almost with certainty, from the very strong affinity of sesquioxyd of uranium for the alkalies.‡ On account of this impurity, as well as the ease with which all these carbonates appear to lose carbonic acid, the observed percentage of carbonic acid should be less than the calculated. Instead of this, it is in nearly every case larger. I suspect, therefore, that the precipitates in question are mixtures of a less basic carbonate with uranate of soda. More of the latter appears to be formed in the precipitate from the sulphate of uranium than in that from the nitrate. Why this should be I cannot explain. What the true composition of the carbonate of uranium would be, if it could

* Analytical Chemistry, French ed., ii, 252.

† The carbonates of iron, chromium and alumina, after washing with cold water contained not a trace of soda. The carbonate of glucina contained a mere trace, which could probably have been removed by further washing.

‡ For example: the sesquioxyd of uranium cannot be separated from the alkalies by ammonia. Only the excess of alkali is separated. The rest is precipitated with the uranium, as uranate of the alkali. See Rose, Analt. Chem., Fr. ed., ii, 252.

be obtained pure, may be with probability inferred from the composition of its double salts with carbonate of potash and with carbonate of ammonia, in which it exists, according to Ebelmen,* as U_2O_3, CO_2. On the other hand, as the salts of the sesquioxyd of uranium, with the stronger acids, contain only one equivalent of acid, instead of three like those of the other sesquioxyds, analogy with the carbonates just described should make the carbonate of uranium contain less than one equivalent of acid to one of base. The first view is, however, I think, the more probable one.

Summary of the above results.

The following is a brief summary of the principal results arrived at in the foregoing pages:

1. All the carbonates in question, except, perhaps, the carbonate of uranium, lose carbonic acid readily, during the processes of washing and drying. To this may, in a great measure, be attributed the discordant results of previous observers.

2. The precipitate, produced by the alkaline carbonates in solutions of the persalts of iron, has the composition Fe_2O_3, CO_2.

3. The precipitate by the alkaline carbonates, in the violet salts of the sesquioxyd of chromium, varies somewhat in composition, but approaches the formula Cr_2O_3, $2CO_2$ and is probably a mixture of this with a little of the more basic salt next mentioned. The results of previous observers render it nearly certain that the above precipitate, by washing and drying, is converted into a more stable salt of the composition Cr_2O_3, CO_2. This latter is formed, when the precipitation takes place at the boiling point. The precipitate in the green solutions of chromium consists of carbonate, not of oxyd as stated by Lefort, and has probably the same composition as in the violet salts.

4. The precipitate by the fixed alkaline carbonates, in the salts of alumina, varies in composition, but approaches the formula Al_2O_3, CO_2 and is probably a mixture of this with a more basic salt. Both in this and in the case of the carbonate of chromium, the normal salt may be obtained nearly free from basic compounds, by pouring the alumina or chromium solution into that of the alkaline carbonate, instead of the reverse, so as to have always an excess of the alkali.

5. The precipitate by the alkaline carbonates, in the salts of glucina, has the composition G_2O_3, CO_2.

6. The precipitate by the alkaline carbonates, in solutions of the sesquioxyd of uranium, is undoubtedly a mixture of uranate of the alkali and carbonate of uranium. The latter, if it could be obtained pure, would very probably have the compo-

* Ann. Chim. et Phys., [3], v, 206–208.

sition U_2O_3, CO_2, in which state it exists, according to Ebelmen, in its double salts with the carbonates of potash and ammonia.

In conclusion, it will be observed that none of these carbonates conform to the theory of Berzelius, that the number of atoms of acid, in a neutral salt, corresponds to the number of atoms of oxygen in the base. On the contrary, their composition is generally the same as that of the salts of the protoxyds, one atom of acid to one of base.

Laboratory of the Lawrence Scientific School, Cambridge, July, 1862.

ART. XXIX.—*Supplements to the Enumeration of Plants of Dr. Parry's Collection in the Rocky Mountains*, (continued from p. 261.)

SUPPLEMENT I.—*Coniferæ*, by Drs. PARRY and ENGELMANN.

DR. PARRY collected too few specimens of the following Coniferæ for distribution, but as his notes are replete with interest they are given here (under marks of quotation) together with a few remarks of my own. G. E.

ABIES GRANDIS, Lindl. Not common in this region, resembling much the Eastern *A. balsamea*. Fendler's N. Mex. No. 828 is the same.

ABIES DOUGLASII, Lindl. "Abundant through the eastern mountain district, except on the higher elevations. A very sightly tree, of the average height of 80 feet, with a graceful oval outline; the spreading branches curving upwards at the extremities. Wood of slow growth, but very indifferent, inclined to warp and crack, turning reddish-brown in drying." This species, as well as the nearly allied *A. Canadensis*, is well distinguished from all our other Pines by the distinctly petioled leaves. Fendler's N. Mex. No. 829.

ABIES MENZIESII, Lindl. "A finely shaped tree, though of rather stiff outline, of rapid growth; wood very compact, but rather coarse grained and pitchy; the logs taper too rapidly to saw up to advantage." Cones pendulous from the end of the branches. Leaves stouter than in any other allied species, stiff and very acute, almost spinescent.

ABIES NIGRA, Poir. Probably the same as the northeastern tree (characterized by the slender and very acute leaves, ovate cones with thin and crenate margin of the scales), a pale-leaved form of which is usually named *A. alba*, but which Prof. Gray has demonstrated to belong to *A. nigra*. The true *A. alba* (leaves somewhat stouter and obtusish, cylindric cones with thickened entire margin of the scales) seems to extend from Canada to the northern Rocky Mountains, where it has been gathered by Bourgeau; but it has not fallen under Dr. Parry's or Dr. Hayden's observation, on the headwaters of the Kettle, Colorado, Missouri and Columbia Rivers, where *Abies nigra* seems to be abundant, extending down to Santa Fe (Fendler, N. Mex. No. 833). Dr. Parry found it

* Schw. xvii, 424, in Gmelin's Handb. Art. Cerium.

"composing almost the entire forest growth of the mountain slopes of Middle Park about the head of Grand River: a magnificent tree, 80 to 100 feet high, with an even, columnar trunk, below, 2–2½ feet in diameter, tapering upwards; of rapid growth; bark scaly, smooth and quite thin, of a purplish-brown color, full of tannin, and quite different from the rough brown bark of *A. nigra* of Wisconsin; wood remarkably white and soft, free of knots and scarcely resinous, preferred for inside work." Could this be *Abies rubra* Loud., and specifically distinct from *A. nigra?*

Pinus aristata, Engelm., in St. Louis Transact., vol. 2, tab. 5 and 6. Dr. Parry had the good luck to discover this very peculiar and exclusively alpine species "which does not descend lower than 9000 or 10,000 feet," on the higher mountains of Clear Creek. As a full description and a figure has been given in the Transactions of the St. Louis Academy, I confine myself here to the statement that it is our only representative of Endlicher's section, *Pseudostrobus,* which comprises numerous Mexican, a few Central American, and a single West Indian species; it is characterized by quinate entire leaves and horizontal ovate cones, with thin apophyses on the long-mucronate or aristate scales, and small winged seeds. In sheltered situations it forms a tree 40 or 50 feet high and 1 or 2 feet in diameter, but on the higher bleak mountains it is a stunted bush, often thickly covered with fruit. Its growth, at least in the latter localities, is exceedingly slow, as a stick of scarcely more than one inch in diameter, brought back by Dr. Parry, shows nearly fifty annual rings, some of them $\frac{1}{50}$ of a line, and none more than $\frac{1}{6}$ of a line wide.

Pinus flexilis, James. This species, discovered in the same regions by Dr. James, has to some extent remained doubtful, as his description in the account of Long's Expedition, and Torrey's diagnosis in the Annals of the New York Lyceum (vol. ii, p. 249) are based on notes only, no specimens having been collected. By later writers it has been ignored, until Mr. Fendler in 1847 collected it on the mountains above Santa Fe, (Coll. N. Mex. No. 832), when a short notice was published by the writer in the appendix to Wislizenus' Memoir of a Tour to New Mexico, etc., 1848. Endlicher, in his Synopsis Coniferarum, 1847, does not enumerate it, and Carrière in his Traité des Conifères, 1855, credits it to Wislizenus, translating only my short remarks. Nuttall, however, had already (in 1849) given a somewhat extended account of it, with a poor figure, in the continuation of Michaux's Sylva (vol. iii, p. 107, pl. 112), without clearing up the doubts, which Dr. Parry in his present expedition, 1862, is expected finally to settle. My brother, H. Engelmann, collected it on the head waters of the Platte, and Dr. Hayden on the mountains about the head waters of the Yellowstone, Missouri and Columbia rivers. Dr. Parry notes that the cones grow several together, "semipendulous" at the extremity of the horizontal branchlets; while James gave his plant "erect" cones. Near Santa Fe it grows at the elevation of 8000 or 10,000 feet, and in favorable situations becomes 60 or 80 feet high and bears "pendulous" cones, according to Fendler's note. *Pinus flexilis* is certainly intermediate between the sections *Cembra* and *Strobus* of Endlicher, and unites the two, as does *P. cembroides,* Newberry, Pacif.

R. Rep., vol. vi, Bot., p. 44, not Zucc.,* if, indeed, this is not a mere form of *P. flexilis*, approaching by its short cones close to *P. Cembra*. The large seeds of *P. flexilis* are, as Dr. James already stated and as Dr. Hayden confirmed, eaten by the Indians. They are distinguished from those of any other of our Pines by a persistent, sharp, keeled margin, representing the wing.

Pinus ponderosa, Dougl., is "common through all the lower valleys and less elevated districts of the mountains, associated with *A. Douglasii* and *A. Menziesii*; a most valuable timber tree." Fendler's N. Mex. No. 831. Male aments cylindrical, several inches long.

Pinus contorta, Dougl., "is quite abundant on the crest and slopes of dry subalpine ridges, forming the principal part of the forest there, and extending to near the snow line; a symmetrical tree of rapid growth, 30 or 40 feet high, with slim and tapering trunk a foot in diameter, a smoothish, grayish-brown bark, detached in thin scales, and tough but coarse wood, which is liable to warp, and rarely cut into boards."

Supplement II.—Revision of the *Œnotheræ* of the subsection *Onagra*; by Dr. Engelmann.

[*Prefatory Note*, by A. Gray.—Nuttall, in his Genera, stated that Pursh had confounded two species under *Œ. albicaulis*, viz., his own *Œ. albicaulis* and *Œ. pinnatifida*. In *Plantæ Wrightianæ* I had come to the conclusion that Pursh was right, not then knowing the seeds of *Œ. pinnatifida*, Nutt. Consequently, when good fruit of the latter came to hand, in Wright's second collection, in Pl. Wright, 2, p. 56, I carelessly referred the specimens to *Œ. coronopifolia*, on account of their seeds, notwithstanding their longer capsules, overlooking the other characters, and wrongly supposing that Nuttall's description of the seeds of his *Œ. pinnatifida* or *Bradburiana* somehow belonged to *Œ. coronopifolia*, which, as I had shown in Pl. Fendlerianæ, has such seeds, while those of *Œ. albicaulis* are longer and smooth. Dr. Engelmann has recently corrected this oversight, and in the following memorandum has established the three species upon a good foundation. I greatly doubt the distinctions based upon the duration of the root, although *Œ. albicaulis* and *Œ. coronopifolia* generally, if not always, have the appearance of being perennial, while

* Zuccarini's plant of that name is one of the curious little group of American Nut-pines, including the following four species: *Pinus monophyllos*, Torrey and Fremont, with single (not connate, as Endlicher would have it) leaves; *P. edulis*, Engelm., with 2 leaves; *P. cembroides*, Zucc., (including *P. Llaveana*, Schiede. not Torr., and *P. osteosperma*, Engelm.) with 3 leaves; and *P. Parryana*, Engelm. (*P. Llaveana*, Torr. Bot. Mex. Bound., p. 208, t. 53) with 3–5, mostly 4 leaves. Other characters, taken principally from the bracts of the young shoots, strengthen the specific distinctions. This very natural little group is characterized by the small, almost globose cones, the scales bearing large pyramidal apophyses and large edible seeds, the wings of which remain attached to the scale, which, I suspect, is the case in all "wingless" seeds of pines; in *P. Pinea*, however, the wing is very distinct and detaches itself clearly from the scale and at the same time also from the seed itself, which is likewise the case in the closely allied, though 5-leaved, Californian *P. Torreyana*, Parry, where the wing, besides, is very thick, and of a corky substance. The great variability in the number of leaves in the nut-pines proves that sectional characters taken from them are without value.

Œ. pinnatifida flowers early from a slender monocarpic root; I should not rely much upon the shape and size of the petals; and the leaves are most polymorphous. But, in brief,

Œ. CORONOPIFOLIA, Torr. and Gray, is well marked by the strong villosity of the throat of the calyx, the short and thick, ovoid-oblong, or at most linear-oblong capsules, and the large, oval or oblong, strongly costate seeds, the ribs tuberculate.

The two following both have the calyx glabrous (rarely with a few hairs) in the throat, much larger petals, and larger pods.

Œ. PINNATIFIDA, Nutt., has less elongated and stouter capsules, and small, ovoid, striate-reticulated seeds (with pits between the ribs), apiculate at the hilum.

Œ. ALBICAULIS, Nutt., in all its forms, has elongated-oblong and perfectly smooth seeds, and its longer, linear, capsules are closely sessile by a broad base, and mostly porrected or divaricate from the axis which bears them, often flexuose.

Dr. Parry's No. 116 is *Œ. pinnatifida ;* his 117, probably a canescent form of *Œ. albicaulis ;* neither are in fruit.

The following communication from Dr. Engelmann was received too late for insertion in its proper place in the July No. of the Journal. A. G.]

"A large suite of specimens enables me to clear up some difficulties which have environed the following species of *Œnothera.*

"1. ŒNOTHERA CORONOPIFOLIA, Torr. & Gr. Fl. 1, p. 245; Gray, Pl. Fendl., p. 43. Perennis, saepe multicaulis, humilis, erecta seu erecto-patula, puberulo-canescens, strigosa seu hispida; foliis infimis lineari-spathulatis, caeteris pectinato-pinnatifidis; *tubo calycis ad faucem dense villoso; petalis suborbiculatis integris* stamina aequantibus pistillo brevioribus; capsula ovato-seu lineari-oblonga *torulosa basi nunc in pedicellem brevissimum attenuata suberecta ; seminibus magnis ovatis turgidis subobtusis varie oblique truncatis tuberculatis.* My specimens were collected by Mr. Fendler (No. 222) near Santa Fe, along waterducts, and by Dr. Hayden on the sandhills of the Loupfork, on "Running Water." Stems $\frac{1}{2}$—1 foot high: flower white, turning deep red, about an inch in diameter: capsule in Fendler's specimens about an inch long, in Hayden's only about 4 lines long, thicker than in the allied species: seeds yellowish-brown, about a line long, thick, beset with tubercles arranged in longitudinal rows.

"2. ŒNOTHERA PINNATIFIDA, Nutt., Gen. 1, p. 245; Torr. & Gr. Fl. 1, p. 494. *Œ. albicaulis*, Pursh, Fl. 2, p. 733: DC. Prodr. 3, p. 51, non Nutt. *Œ. Purshii*, Don. Syst. 2, p. 688. *Œ. Purshiana*, Steud. Nom. 2, p. 207: Annua seu biennis, humilis, diffusa, (rarissime erecta), puberula, rarius sursum hirsuta; foliis imis obovato-spatulatis acutis seu obtusis integris, caeteris pinnatifidis saepe ciliatis; *tubo calycis ad faucem nudo; petalis late obcordatis seu profunde emarginatis genitalia superantibus;* capsula lanceolato-lineari *torulosa sessili suberecta ; seminibus ovatis turgidis utrumque apiculatis foveolatis seriatim inter costas dispositis eleganter notatis.* Sandy soil on White River, Upper Missouri, Nuttall, Geyer in Nicollet's Expedition, Dr. Hayden; Las Vegas and Santa Fe, New Mexico, Dr. Wislizenus, Mr. Fendler; the latter's specimens, few in number, bearing his private number 239, were distributed with others of the next species under No. 223; Southern New Mexico, Wright (referred to Œ.

coronopifolia in Pl. Wright, 1, p. 69.) All the specimens I have seen are either annual (sometimes simple and one-flowered) or, usually, biennial, with rosulate entire radical leaves; branching from the base, diffuse or even decumbent; an erect form was collected by A. Gordon on the Upper Canadian River, No. 29, similar to the last species in habit. Stems usually 4–6 inches high, but, according to Nuttall, the decumbent branches sometimes 2 feet long. Flowers $2\frac{1}{2}$–3 inches in diameter, white, turning pale red: capsule 1–$1\frac{3}{4}$ inches long: seeds very regularly and prettily pitted between the longitudinal ribs, 0·6–0·7 of a line long, yellow. Don and Steudel have changed Nuttall's earlier name, but his must stand and Humboldt's plant, described five years later under the same name, may receive the name of *Œ. Humboldtii.*

"3. Œnothera albicaulis, Nuttall in Fras. Cat., 1813, & Gen. 1, p. 245; Torr. & Gr. Fl. 1, 495; Gray Pl. Wright 1, p. 69, & 2, p. 56: Perennis, glabra, puberula seu hirsuta; caulis *cortice albida membranaceo nitente;* foliis maxime variis; *petalis orbiculato-ovatis* in unguem plus minus attenuatis *integris* stamina superantibus pistillum aequantibus; *sapsula e basi crassiore sessili lineari divaricata saepe flexuosa seu deflexa; ceminibus minoribus lineari-lanceolatis laevibus.* A common plant on the western plains, extending into Oregon, New Mexico and Chihuahua, as variable in habit, growth and foliage as it is common, but always easily recognized by the unvarying characters of the flower and fruit as above indicated, and also by its white glistening stems and branches, the epidermis of which is apt to peal off in the manner of many Loasaceæ. The white flowers, $1\frac{1}{2}$–$1\frac{3}{4}$ inches in diameter, at last turn pale-red; the very slender capsule, connected by a very thick base with the stem, is usually $1\frac{1}{2}$–$1\frac{3}{4}$ inches long, and spreads at right angles, or is curved or twisted in various directions. Seeds smooth, dark-brown, lance-linear and usually very acute at one end, and 0·8 line long; var. δ, has smaller (0·6 line) and obtuse seeds. According to foliage and pubescence I arrange the specimens before me under the following varieties:

a. Foliis basi in petiolum brevem attenuatis.

Var. *α.* Nutallii: erecta, glabriuscula seu puberula, simplex seu ramosa; foliis linearibus seu lanceolatis seu oblongis integris vel plus minus dentatis. Here belongs *Œ. pallida*, Dougl., with its variety *leptophylla*, Torr. & Gr., as already indicated by Prof. Gray. Nuttall describes this form as sometimes 3 feet high, and Geyer notes that in the sandy plains of Devil's Lake and at the sources of St. Peter's River it forms shrubby bushes of the size of Spartium scoparium, growing even 4 feet high; but it seems more usually between one and two feet high. Leaves 1–$2\frac{1}{2}$ inches long and 1–6 lines wide. One of the broadest leaved forms is Fendler's N. Mex. No. 224.

Var. *β.* runcinata: branchiato-ramosa, patula, glabra, puberula seu canescens; foliis lanceolatis grosse seu sinuato-dentatis. This is *Œ. pinnatifida*, Gray Pl. Fendl., p. 43 (description and most of the specimens No. 223, all those with the private number 243). Fendler gathered it near Santa Fe; Fremont in his 3d Expedition collected a glabrous (No. 222) and a very canescent (No. 178) form, the latter with singularly short but apparently fertile capsules, scarcely 3 lines long.

b. Foliis basi lata truncata sessilibus.

Var. γ. BREVIFOLIA: tota glaberrima, erecta, ramosissima; foliis late ovatis abbreviatis grosse dentatis. Sandhills south of El Paso, Dr. Wislizenus, No. 99. Leaves dark green, while all the other forms are pale or grayish, 4–6 lines long, acutish, or often rounded at the end.

Var. δ. TRICHOCALYX: erecta, parce ramosa, canescenti-hirsuta; foliis lanceolatis seu lanceolato-oblongis sinuato-dentatis. Las Vegas, New Mexico, Dr. Wislizenus, No. 473.—This is no doubt Nuttall's *Œ. trichocalyx*, Torr. & Gr. Fl. l. c., the specific identity of which with *Œ. albicaulis* Prof. Gray has already indicated. The long hair on the stem, ovary, and especially the calyx, consists of a single cell, remarkably broad at base, tapering to an acute point;—it is however the form of hair I find in all long-haired *Œnotheræ*. G. E.

SUPPLEMENT III.—Revision of the genus *Castilleia*; by A. GRAY.

CASTILLEIA, Linn. f.

The species of this genus are most troublesome and unsatisfactory, not only on account of the difficulty of investigating the dried specimens, but also from the variability of the characters which have been relied npon in arranging them, and especially of the calyx. Although the latter affords good characters on the whole, yet the degree of fission and the form of the lobes are far from being constant in several species; and the same remark applies in a measure to the relative length of the galea and of the lower lip. The structure of the lower lip is likely to afford some good characters; but they are not readily nor very safely to be derived from dried specimens. Bentham's four sections (in De Candolle's Prodromus) do not prove to be as distinct as they would seem. The second and the third were better combined into one, which will include all our North American species but two. The fourth section is pretty well marked, but not absolutely. Of the first, which would appear to be quite distinct, I have no specimens. Beginning with Bentham's fourth section, since this comprises the original species :—

§ 1. HEMICHROMA or EUCASTILLEIA. Calyx (sæpe incurvus) antice profunde fissus, postice leviter bifidus sæpius 4-dentatus.

C. LINARIÆFOLIA, Benth., is one of the best characterized and the most northern species. It is known by its long, narrow and glabrous cauline leaves which are not dilated at the base, the floral ones scarlet-colored, by the subulate teeth of the calyx, and by the long and narrow galea, which is more slender and falcate than in *C. tenuiflora;* the lobes of the lower lip linear-subulate. But the flowers are not always sessile, nor the leaves only one-nerved and entire; these are often 3-cleft or 3-parted, and more or less distinctly 3-nerved at the base. To this species clearly belongs *C. fulgens*, Nutt. in herb. Philad., and *C. candens*, Durand in Pacif. R. R. Rep. 5, p. 12. (But No. 70 of the Californian (Fort Tejon) collection of Xantus, also specimens collected by Dr. Newberry in the Colorado expedition, which I had mistaken for *C. candens*, belong to *C. affinis*). This is No. 583 of Fendler's New Mexican collection, and 246 of Dr. Parry's Rocky Mountain collection.

C. TENUIFLORA, Benth., Pl. Hartw. No. 191, as Bentham intimates, should probably include *C. longiflora*, Kunze, and *C. canescens*, Benth., (which is Gregg's No. 434, 610, and Coulter's No. 1354), all from Mexico.

C. ORIZABÆ I have not seen, unless Coulter's No. 1352 and 1353 belong to it.

C. FISSIFOLIA, Linn. f. (No. 835, coll. Venezuel. Fendler). To this Weddell refers all the five other South American species of this section, including even *C. integrifolia*, Linn. f.

C. LAXA, Gray in Bot. Mex. Bound., p. 119, of Arizona (coll. C. Wright, No. 1490), has a broader calyx and corolla than any of its allies, the former very thin-membranaceous, colored, and with obtuse teeth, the galea slightly falcate; the leaves thin and not dilated at the insertion.

§ 2. EUCHROMA (incl. *Callichroma*). Calyx antice et postice fissus, segmentis integris emarginatis vel bifidis.

I have nothing to say of the six Mexican and South American species in the Prodromus. The proper North American ones I understand as follows:

* *Radice annua vel bienni.*

+- *Integrifoliæ.*

C. AFFINIS, Hook. & Arn. Folia lineari seu lanceolato-attenuata, floralia raro trifida: flores pl. m. pedicellati: calyx usque ad medium bifidus, segmentis angustis saepius bifidis vel emarginatis: galea elongata falcata; labium brevissimum.—The calyx is generally cylindrical, more or less curved, and reddish, and the wholly exserted galea 6 to 8 lines long: but the species, I believe, passes by regular gradations into the

Var. MINOR, Gray in Bot. Mex. Bound., p. 119 (*Euchroma simplex* and *E. lanceolata*, Nutt. in herb. Acad. Philad.), which has smaller flowers, less colored floral leaves, a green and herbaceous calyx, the galea of the pale corolla only three or four lines long. Hartweg's No. 1877 is a good intermediate form. The calyx in both forms (as I have elsewhere noted) varies with its segments deeply bifid, moderately bidentate, or entire.

C. INDIVISA, Engelm. Folia caulina lineari-lanceolata, floralia obovato-dilatata rarius sublobata: flores sessiles: calycis segmenta lata sæpius emarginata; galea brevis breviter exserta. I have not the means of collating this with *C. lithospermoides*.

+- +- *Laciniatifoliæ.*

C. COCCINEA, Spreng. The only annual, or perhaps biennial, species with laciniately cleft leaves; confined to North America east of the Rocky Mountains, and mostly east of the great plains, ranging from Rupert's Land to Texas.

* * *Radice perenni.*

+- *Foliis floralibus superne pl. m. dilatatis et coloratis.*

++ *Villoso-pubentes, vel inferne glabræ, pube versus apicem caulis, etc., patente pilosa vel hirsuta sæpius viscosa.*

C. PARVIFLORA, Bongard. Fere undique piloso-pubescens vel hirsuta, vix hispida: folia pleraque trifida vel pinnato-laciniata, floralibus apice sæpissime rubro-colorata: calycis segmenta aut emarginato-biloba, aut profunde bifida lobis oblongis seu linearibus: corollæ labium brevissimum.

—This is apparently the commonest species and of widest range west of the Rocky Mountains, extending from Russian America to Southern California. The name given by Bongard is much the earliest, but not a good one, being founded upon what, I believe, is only a northern form of Bentham's *C. hispida* (a later and scarcely more appropriate name), with a less developed corolla. The length of the galea appears to be subject to variation in this species, as in *C. pallida*, and the calyx-segments still more so. To the present species may be referred: *C. coccinea*, Lindl. Bot. Reg. t. 1136 (non Spreng.), which, as its calyx-segments are described as being dilated and retuse, Mr. Bentham should rather have referred to his *C. Douglasii*. *Euchroma angustifolia* and *E. Bradburii*, Nutt.! in Jour. Acad. Philad. 7, p. 44, 47 (1834), both hirsute forms with deeply cleft and narrow calyx-segments. *Castilleia hispida*, Benth. in Hook. Fl. Bor. Am. & in DC. Prodr., 10, p. 532. *C. Douglasii*, Benth. in DC. l. c. p. 530; the commoner form, with oblong or more dilated and slightly lobed or cleft calyx-segments. *C. desertorum*, Geyer in Hook. Kew Jour. Bot. 5, p. 258, which is just Nuttall's *E. angustifolia*, but with partly yellow bracts. *E. macrocalyx*, *E. villosa*, *E. laciniata*, and *E. viscosa*, Nutt. in herb. Acad. Philad.

C. PALLIDA, Kunth. Inferne sæpius glabra vel glabrata, caule versus apicem calycibusque villosis: folia inferiora sæpissime integra (e forma lineari ad ovato-lanceolatam), floralia vulgo pl. m. incisa vel laciniata et albido-colorata: calycis segmenta bifida seu biloba: galea aut breviuscula aut elongata.—The most northern species, and extending round the world on the borders of the arctic zone. I am well satisfied (especially from White Mountain specimens, clearly all of one species) that the galea varies much in length or degree of development,—the lower lip remaining nearly uniform,—and that, accordingly, *C. Sibirica* and *C. septentrionalis* of Lindley are states of one species, *C. pallida*,—to which belong *C. acuminata*, Spreng. (*Bartsia acuminata*, Pursh), *C. occidentalis*, Torr. (a dwarf alpine form), *Euchroma lutescens*, Nutt. in herb. Acad. Philad., and, as a variety:—

Var. MINIATA: viridior, inferne glabra; foliis floralibus pl. m. miniatis; galea elongata magis exserta. *C. miniata*, Dougl., Benth. *Euchroma integrifolia*, Nutt. in herb. Hook. & Acad. Philad. This is pretty well marked on the whole; but in Rocky Mountain specimens it runs both into *pallida* and *septentrionalis*. As to "*C. pallida* var. *Unalaschensis*, Cham. and Schlecht.," from Sitcha, my specimens from Bongard consist of narrow-leaved ones with a short galea (true *C. pallida*) and a broader-leaved one with elongated galea, good *C. septentrionalis*, apparently, referred by Bentham to *C. miniata*. C. No. 1, Bourgeau's coll. in Palliser's Exped., is *C. miniata* with the upper cauline and floral leaves unusually cleft.

C. LATIFOLIA, Hook. & Arn. Undique viscoso-hirsuta, laxe ramosa: folia brevia, obovata, obtusissima, plerisque integra, floralia apice dilatata, 3–5-lobata, rubro-colorata: calycis segmenta lata emarginato-biloba: corolla parva. A well-marked Californian species. The comparatively short and broad calyx is sometimes equally cleft before and behind, sometimes much deeper posteriorly.

++ ++ *Tomentosæ, vel pube caulis molli implexa. Folia caulina linearia integra, vel trifida.*

a. Incanæ; calycis segmentis dilatatis subintegris.

C. FOLIOLOSA, Hook. & Arn. Floccoso-tomentosa, tomento e pilis ramosissimis! Caules suffruticosi cum foliis adultis quandoque glabrescentes: galea ultra segmenta calycis spathulato-oblonga sæpius retusa leviter exserta.—The peculiarity of the pubescence is indicated in Bot. Mex. Bound. Survey, p. 118.

C. LANATA, Gray in Bot. Mex. Bound., l. c. Herbacea, tomento arachnoideo appresso albo-lanata: flores fere *C. foliosæ*, sed majores.

b. Cinereo-puberulæ vel subtomentosæ; calycis segmentis sæpissime bifidis; galea exserta. Folia supra nunc glabra.

C. INTEGRA, Gray in Bot. Mex. Bound. l. c. Caulis laxe tomentosus: folia (sæpius tomentulosa) omnia integerrima, vel floralia sublobata, raro trifida: flores sesquipollicares, galea majore et labio breviore quam *C. purpureæ.*—Besides the numbers already cited, this is No. 244 of Parry's Rocky Mountain collection (a dwarf or subalpine form); and my *C. tomentosa*, from Mabibi, Arizona, Thurber, appears to be a more tomentose state of the same species, the flowers in the specimen not well developed. It is closely related to *C. purpurea*, and perhaps runs into it. To that, at least, I now refer the undistributed specimens of Wright's first collection.

C. PURPUREA, Don. Caulis tomentulosus vel cinereus: folia pubera vel glabrata, superiora vulgo cum floralibus trifida seu laciniata: flores pollicares, labio minus quam in affinibus abbreviato (2–2½ lin. longo). Floral leaves varying from cherry-red to flesh-color, or light yellow. Lower lip of the corolla by no means half the length of the galea in well developed flowers. To this species belongs *C. angustifolia*, Gray in Bot. Mex. Bound. l. c., excluding the synonymy, and excluding the plant of H. Engelmann from Bridger's Pass, the latter being *C. miniata.* It is, accordingly, Wright's No. 1491 and 1492, and Lindheimer's 488 and 669.

+ + *Foliis (plerisque 3–5-fidis lobis linearibus) floralibus apice nec dilatatis nec coloratis. Calyx aut æqualiter aut antice profundius fissus, segmentis alte bifidis. Corollæ labium magis quam in* cæteris *trisaccato-carinatum, lobis galeæ dimidium adæquantibus. Plantæ humiles, subvillosæ vel subcinereæ.*

C. SESSILIFLORA, Pursh. Calyx et corolla tubo elongato angusto; labio tripartito, lobis lineari-lanceolatis. Corolla evoluta bipollicaris, galea 4–6 lin. longa.

C. BREVIFLORA, Gray, Pl. Parry, No. 243. (*Euchroma breviflora*, Nutt. in herb. Philad.) Spithamæa, spica densa, florescente vix pollicari; calyce ovoideo-oblongo, lobis lanceolatis; corollæ luteæ tubo fere incluso, labio inferiore triplicato-saccato breviter trifido, lobis oblongis obtusis.—Rocky Mountains, Nuttall, Parry, No. 243. A well-marked species of this genus; the lip of the corolla about as long in proportion to the galea as in *C. sessiliflora*, but more trisaccate,—therefore one of the transitions to *Orthocarpus.* The calyx in flowers of the same spike is sometimes about equally cleft behind and before, and sometimes split in front while the posterior cleft is no deeper than that between the lateral lobes.

Excludendæ. Small indeed are the absolute distinctions between some of the third section of *Orthocarpus* and *Castilleia.*

Euchroma albida, Nutt. in herb. Acad. Philad., is *Orthocarpus attenuatus*, Gray in Bot. Whippl. Exped. Pacif. R. R. Rep. 4, p. 121. This is the "O. No. 1," of Dr. Lyall's collection on the Oregon Boundary, from Lopez Island, distributed at Kew Gardens.

Euchroma pallescens, Nutt. in herb. Acad. Philad., from the Rocky Mountains, being a near relative of the preceding and of *Orthocarpus densiflorus*, and I believe not a described species, would take the name of *O. pallescens*. The lobes of the lower lip of the corolla are so conspicuous that it can hardly be *O. hispidus*, Benth., a species unknown to me. The segments of the deeply two-cleft calyx are merely bifid at their apex. Near to this, if not the same, but more hairy, with deeper-cleft calyx-segments, and yellowish corolla almost an inch long, are specimens of Geyer's Rocky Mountain collection, distributed as No. 291, therefore probably those mentioned in Hook. Kew Jour. Bot. 5, p. 259. Here also the lobes of the lower lip are quite conspicuous, and the incompletely developed specimens might very readily be taken for those of a *Castilleia*.

SUPPLEMENT IV.—Review of the genus *Mertensia*; by A. GRAY.

MERTENSIA, Roth.

The species of *Mertensia* which I have been able to examine, although not a little perplexing, may perhaps be best discriminated as follows:—

§ 1. Filamenta gracilia antheris multo longiora: corollæ tubo calyce alte 5-fido pluries longiore, limbo levissime lobato, plicis faucialibus nullis. Tota glaberrima.

1. M. VIRGINICA, DC.—The disk is annular, but on each side developed into a large lobe or glandular appendage. That of *M. Fendleri* and of some specimens of *M. paniculata* approaches it. Corolla villous inside just above the obscurely 10-glandular base of the tube.

§ 2. Filamenta antheris plus minus angustiora et longiora: corollæ limbo lobato.

2. M. MARITIMA, Don. Corollæ tubo limbo breviore calycem sub-5-partitum subæqaunte, plicis conspicuis.

3. M. PALLASSII, Don. *M. Sibirica*, DC., &c. *Pulmonaria Sibirica*, Pall., non Linn. *Lithospermum Pallassi*, Ledeb. Corollæ tubo limbo 1½–2-plo calyce 3-plo longiore, plicis tenuibus. Siberia.

§ 3. Filamenta magis dilatata, antheris æquilata seu latiora et plus minus breviora: corollæ limbo 5-fido.

* *Calyx haud ultra medium 5-fidus.*

4. M. FENDLERI (sp. nov.): foliis subtus cauleque lævibus supra cum pedicellis appresse hispidulis, caulinis oblongo-lanceolatis; racemis paucifloris; corollæ tubo lobis calycis hirsuti lato-lanceolatis limboque vix longiore intus supra basim annulato-villoso. New Mexico: foot of hills on Santa Fe Creek, Fendler No. 625. Discus pl. m. bilobus.

* * *Calyx 5-partitus, in M. oblongifolia et M. alpina quandoque alte 5-fidus.*

+ *Corolla tubo quam limbus (i. e. pars dilatata supra faucem) 2–3-plo longiore.*

5. M. Davurica, Don. Gracilis; foliis caulinis linearibus supra cum calyce subincano-hirtis; corolla ima basi annulato-pilosa, cæt. glabra. Siberia. The hairy ring (much less conspicuous than that of the foregoing species) is here at the very base of the corolla, occupying the position in which ten obscure glands or slight thickened spots are generally discernable: these are most evident in the following species, and in *M. alpina.*

6. M. oblongifolia, DC., Hook. Kew Jour. Bot. 3, p. 295. *Pulmonaria oblongifolia*, Nutt.! *Lithospermum marginatum*, Lehm. in Hook. Fl. Bor. Am. Humilis; foliis caulinis oblongis vel spathulato-lanceolatis plerumque obtusis; segmentis calycis lanceolatis seu linearibus acutis corollæ tubo intus glaberrimo 2–3-plo brevioribus. Interior of Oregon, Utah, &c. Varies with the sepals very narrow and ciliate with long and rigid bristles, as in Nuttall's original specimens collected by Wyeth; or with these ciliæ minute or sparse or obsolete, as in most specimens; in Geyer's No. 316, the calyx is hardly 5-parted, and its segments broader; in Spalding's, from Clear Water, the leaves are unusually broad. The leaves resemble those of Heliotropium Curassavicum.

+ + *Corolla tubo quam limbus ad summum sesquilongiore.*

++ *Elatæ, 1–3-pedales: folia caulina ovata seu ovato-lanceolata, acutissime acuminata vel acutata, costato-venosa; corollæ semipollicares seu paullo longiores.*

7. M. paniculata, Don. *M. paniculata, pilosa, pubescens, lanceolata? stylosa? & Kamtschatica?* DC. Hirsuta, hirtula, vel glabrata; segmentis calycis lanceolatis seu lanceolato-linearibus acutis hirsutis vel hispido-ciliatis tubo corollæ intus sparsim piloso paullo vel dimidio brevioribus.—A specimen of *L. denticulatum*, Hook. & Arn. from Kotzebue's Sound in Beechey's Voyage, p. 128, in herb. Torr., is certainly of this species, which probably occurs in Northeastern Asia also. H. Engelmann's specimens from Medicine-Bow Mountains and Dr. Parry's No. 286 are glabrate and dwarf mountain forms of *M. paniculata*, with barely acute leaves, and are Pursh's *Pulmonaria lanceolata.* Nuttall's *P. marginata* is much the same.

8. M. Sibirica, Don, non DC. *M. denticulata* (Don.) *& ciliata*, DC. (*Pulm. Sibirica*, Linn.) Glaucescens, subpubescens, vel glabra; segmentis calycis oblongis seu oblongo-linearibus obtusis ciliolatis tubo corollæ intus sparsim piloso vel fere glabro 2–4-plo brevioribus. Rocky Mountains, Eastern Siberia.

++ ++ *Pumila: folia caulina obtusa vel acutiuscula, vix venosa: corollæ $\frac{1}{4}$–$\frac{1}{3}$-pollicares.*

9. M. alpina, Don. *M. Drummondii*, Don. *Pulmonaria alpina*, Torr. *Lithospermum Drummondii*, Lehm., in Hook. Fl. Bor.-Am. Spithamæa ad subpedalem; foliis spathulato-oblongis lanceolatis vel supremis oblongo-ovatis parvulis; segmentis calycis nunc ovato seu oblongo-lanceolatis obtusiusculis nunc lineari-lanceolatis acutis ciliatis corollæ tubo limbum

adæquante paullo brevioribus.—Either glabrous or hirsute. Richardson's plant from the arctic coast is a large-flowered form of Torrey's *P. alpina.* Parry has an alpine form (No. 287), and a loose, evolute form with longer and narrower leaves (No. 284); in these the tube of the corolla is usually pilose inside near the middle; but it is not so in Torrey's original specimens of *M. alpina*, nor in Hooker's *M. Drummondii.* In the latter, and in Parry's specimens, as in all of the various other species I have examined, the stamens are inserted in the throat of the corolla. In the flowers of Dr. James' specimens, they are inserted pretty low down on the tube, so that the tips of the anthers barely reach to the level of the faucial plicæ or appendages. This is the case in all the various specimens I have examined (of Burke, Fremont, and Stansbury) from the western side of the Rocky Mountains, of what seems to be a narrow-leaved and hirsute variety of this species. Contrary, however, to the dimorphism in other *Borragineæ, Rubiaceæ*, &c., the included stamens are here accompanied by a *short* style.

§ 4. Filamenta antheris sublongiora et equilata: corollæ limbo lobato: achenia echinata!

10. M. RIVULARIS, DC. *M. elliptica*, Ledeb. ex Regel & Tiling, Fl. Ajan. N.E. Siberia and Kamtschatka. Corolla with the tube hairy within towards the base: plicæ at the throat conspicuous. I have only a specimen from Tiling's Ajan collection. In this the fruit is conspicuously *echinate* with soft prickles,—a remarkable peculiarity, which is not noticed in Regel's account of this collection.

⁂ Dr. Hooker, in his Arctic Essay, received long since the above was written, adopting Sir William's suggestion, refers the high arctic *M. Drummondii* (*Lithospermum Drummondii*) to our *M. Virginica.* Although Lehmann describes the corolla "*fauce notata protuberantiis quinque*, I found no appendages in an original specimen in herb. Torrey, just as Dr. Hooker notes. But I also found them obsolete in specimens of *M. alpina* and of other species in which they are sometimes evident. Wherefore I rejected the character from the diagnosis of Section 3.

ART. XXX.—*Researches on the Platinum Metals;* by WOLCOTT GIBBS, M.D.

(Continued from vol. xxxi, p. 71, Jan., 1861.)

§ 3.

THE mass of soluble chlorids obtained by the above method contains all the platinum metals, although only traces of osmium and palladium are present; in addition there is usually more or less insoluble matter, consisting partly of the impurities of the ore itself and partly of undissolved oxyds. A certain portion of iron also remains with the mass even after careful washing. The washings contain a very large quantity of iron, a little ruthenium in the form of bichlorid of ruthenium and potassium, and possibly a trace of palladium. When the washing with chlorid of potassium has been carefully executed with a cold and saturated solution, the quantity of ruthenium dissolved is too small to be worth separating. It only remains therefore to separate the metals in the mass of mixed double chlorids. Platinum and iridium exist in this mass in the form of bichlorids, as $PtCl_2,RCl$ and $IrCl_2,KCl$; ruthenium is present partly as sesquichlorid and partly as bichlorid, $Ru_2Cl_3,2KCl$ and $RuCl_2,KCl$; rhodium appears to be present only as sesquichlorid, $Rh_2Cl_3,3KCl$, so far at least as it is possible to determine. The separation of these metals from each other is a problem of no ordinary difficulty.

Of the methods which have been proposed for this purpose I have no hesitation in saying that that of Claus is the only one which yields the different metals in a state of purity. In fact after a long and laborious study of the subject I believe that no other chemist has worked with pure preparations of iridium and rhodium, the descriptions even of Berzelius applying only to mixtures of isomorphous salts in various proportions. In addition the discovery of ruthenium by Claus rendered a complete revision of the subject necessary. Such a revision Claus has himself given in his elaborate and most valuable memoir already cited.* For the details of Claus' processes I must refer to his paper. In principle his method consists in separating osmium and ruthenium by fusion with a mixture of caustic potash and saltpeter; cold water then dissolves out osmate and ruthenate of potash. The residual mass consists chiefly of the oxyds of iridium, rhodium and platinum. These, after distillation with aqua-regia, are brought into the form of double chlorids with ammonium; the iridium reduced to sesquioxyd by means of sulphydric acid, and the platinum separated from the other two metals by washing with a strong solution of sal-ammoniac. The filtrate from the chlorplatinate of ammonium contains iridium and rhodium as sesquichlorids; the iridium is converted by chlorine and nitric acid into bichlorid, and the insoluble chloro-iridate of ammonium separated by filtration from the soluble rhodium salts. This method has given excellent results in the hands of its author but is not free from objection, the chief difficulty lying, in my opinion, in the separation of ruthenium from iridium. The ruthenium salt $Ru_2Cl_3,2KCl$ is scarcely to be distinguished in appearance from the iridium salt $IrCl_2,KCl$; it possesses about the same degree of solubility in water and in solutions of chlorid of potassium and ammonium. By the action of reducing agents the sesquichlorid of ruthenium is reduced, apparently to a protochlorid, the double salts of which, like $Ir_2Cl_3,3KCl$ and Ir_2Cl_3,

* Beiträge zur Chemie der Platin-metalle. Dorpat, 1854.

$3NH_4Cl$, are quite soluble in water. Oxydizing agents readily convert the proto-chlorid of ruthenium into sesquichlorid, which is again precipitated in Claus's process with $IrCl_2,KCl$, in the form of $Ru_2Cl_3,2KCl$. The portion of ruthenium which exists in the mass of double chlorids in the form of $RuCl_2,KCl$ may be easily and almost completely removed by repeated and careful washings with a cold and strong—but not saturated—solution of chlorid of potassium, in which the salt, $RuCl_2,KCl$, is soluble, while the other double chlorids remain undissolved. The small quantity of ruthenium dissolved in washing out the sesquichlorid of iron may be recovered by precipitating the iron carefully with a solution of carbonate of potash, adding a slight excess of chlorhydric acid to the filtrate, and evaporating to dryness, when the ruthenium salt remains mixed with a great excess of chlorid of potassium. In Claus's process however this method is of little use since the greater part of the ruthenium is removed in the form of ruthenate of potash, while another portion remains as $Ru_2Cl_3,2KCl$, insoluble in chlorid of potassium.

Another difficulty in Claus's process arises from the fact that the rhodium salt, $Rh_2Cl_3,3NH_4Cl$, is quite insoluble in a strong solution of chlorid of ammonium, while a weak solution of the same salt dissolves a considerable portion of the iridium and ruthenium salts, $IrCl_2,KCl$ and $Ru_2Cl_3,2KCl$.

Claus's method of separating ruthenium—in the form of Ru_2Cl_3—from iridium, by adding a few drops of ammonia to the neutral solution and boiling so as to precipitate Ru_2O_3+xHO, gives good results when the quantity of ruthenium is large in proportion to the iridium present, but not otherwise. Small quantities of ruthenium cannot be separated at all by this process, nor have I in any case been able to obtain iridium absolutely free from ruthenium by boiling. For these reasons, while doing full justice to the extraordinary skill and success of the Russian chemist, I have still thought the problem of the complete separation of the metals of the platinum group worthy of a new investigation.

The method which I now use consists essentially in the employment of the alkaline nitrites as separating agents; in addition, however, I avail myself, as Claus has so skillfully done, of the different degrees of solubility of the double chlorids of the platinum and alkaline metals.

The relations of the alkaline nitrites to the platinum metals have not hitherto been studied and require special attention in this place. The remarkable double salts which these metals form when treated with the nitrites of potash and soda will be fully described hereafter, but the general character of the salts themselves, upon which my methods of separation are based, may advantageously precede the details of their practical application.

Osmium.—A solution of osmic acid is reduced by addition of nitrite of potash to osmious acid, which unites with the alkali, forming the well known beautiful red salt discovered by Fremy. The solution may be evaporated to dryness without decomposition. The nitrite may therefore be added with great advantage when solutions containing free osmic acid are to be evaporated, or even transferred from one vessel to another. No other reducing agent yet applied answers the same purpose, as the osmium is obtained at once in a very convenient form for preservation. When a solution of osmic acid, to which nitrite of potash has been added, is evaporated sufficiently and then allowed to cool, beautiful garnet red octahedral crystals of the osmite of potash separate. These should be dried *in pleno*, over sulphuric acid, and not in contact with paper or organic matter, which partly reduces the osmious acid to the brown sesquioxyd of osmium. Nitrite of potash exerts no sensible action when boiled with a solution of chloro-osmate of potassium. Any salt which may be formed is very soluble in water.

Ruthenium.—When a solution of nitrite of potash is added in excess to the sesquichlorid of ruthenium, either free or in combination with chlorid of potassium or ammonium, a yellow or orange-yellow color is produced, but no precipitate is formed. A precisely similar change occurs when the ruthenium is in the form of bichlorid, but in this case the change of color is produced more slowly, and usually requires heating or even boiling. The change of color produced is in both cases owing to the formation of an orange-yellow double salt of ruthenium and potassium which is very soluble in water and alcohol; its relations to alcohol in particular enable us to distinguish ruthenium from the other platinum metals more perfectly than has hitherto been possible. Nitrite of soda forms a similar salt with solutions of the bichlorid of ruthenium.

When a few drops of sulphid of ammonium are added to a solution of the ruthenium double salt above mentioned, a magnificent crimson color is produced. This reaction furnishes a characteristic test for ruthenium of the greatest value, since it is not, like Claus's beautiful reactions with sulphocyanid of potassium or sulphuretted hydrogen, materially affected by the presence of the other metals of the same group. The test may be most advantageously applied as follows: The liquid supposed to contain ruthenium is first to be rendered neutral or alkaline by addition of carbonate of soda or potash. I prefer to use an excess of alkali. Nitrite of potash in solution is then to be added, the liquid boiled for an instant, allowed to be become perfectly cold and a drop or two of colorless sulphid of ammonium added. On shaking, the color appears and rapidly deepens to the finest red. When the quantity of ruthenium present is very small, or when large quantities of the other platinum metals are also present, it is better, after adding the alkaline carbonate and nitrite, to evaporate the whole to perfect dryness on a water-bath and treat the dry and powdered mass with a small quantity of absolute alcohol. The alcoholic solution is then to be filtered off, and tested directly with sulphid of ammonium. In this manner, the smallest trace of ruthenium may be detected, even in the presence of very large quantities of the other platinum metals. A solution of the double nitrite of ruthenium and potassium is completely precipitated by a long continued current of sulphydric acid gas. Sulphid of ammonium also precipitates the solution after a short time, but when added in excess redissolves the dark chocolate-brown precipitate. The addition of a slight excess of dilute chlorhydric acid then completely precipitates the sulphid of ruthenium.

Iridium.—When a solution of nitrite of potash or soda is added to one of chloro-iridate of potassium or ammonium, the color of the solution instantly changes to olive-green, the iridium being reduced from bichlorid to sesquichlorid. The reduction takes place most rapidly in a hot solution, in which it is almost instantaneous. When the solution cools, the new double chlorid usually crystallizes. An alkaline nitrite is a far more elegant and convenient reducing agent for the separation of iridium from platinum than either sulphuretted hydrogen, sulphurous acid or cyanid of potassium. The reduction in question is expressed by the equation,

$$2(IrCl_2.KCl)+KO, NO_3=Ir_2Cl_3, 3KCl+NO_4$$

A very different result is however produced when an excess of nitrite of potash is added to a solution containing either of the chlorids of iridium, and the solution is boiled for a few minutes or even allowed to evaporate spontaneously. The olive-green liquid becomes yellow and contains the whole of the iridium in the form of a double salt which is soluble in water but insoluble in alcohol.

When however the solution is boiled, an excess of the alkaline nitrite being present, part of the iridium is thrown down as a heavy snow-white powder, which is insoluble in cold water; hot water dissolves it in small proportion; the solution however speedily becomes milky and remains so for a long time. Chlorhydric acid even on boiling exerts but little action upon it. Nitro-muriatic acid with the aid of heat gradually yields a solution containing bichlorid of iridium. The insolubility of this compound in water and acids is very remarkable, the similar salts of the other platinum metals being nearly all readily soluble either in water or in dilute acids. Nitrite of soda under the same circumstances forms with iridium a soluble orange-yellow salt. The two soluble double nitrites of iridium and potassium or sodium give no precipitate with alkaline sulphids even on boiling. The soda salt is easily decomposed by boiling with chlorhydric acid, giving a solution of chloro-iridate: the potash salt is decomposed with great difficulty.

Platinum.—Solutions of the alkaline nitrites exert a scarcely sensible reducing action upon chlorplatinate of potassium or ammonium, even after long boiling. The salt retains its color and crystallizes unchanged from the solution on cooling. When other metals belonging to the same group are present, and the solution after adding the nitrite is boiled for some time, a small quantity of platinum is dissolved, giving a yellow salt very soluble in water and alcohol. When nitrite of potash is added to a solution of platinum, sulphid of ammonium immediately throws down a brown precipitate of sulphid of platinum: the same effect is produced in a solution of the yellow salt above mentioned.

Palladium.—A solution of either protochlorid or bichlorid of palladium immediately becomes yellow or orange-yellow, when an excess of nitrite of potash is added to it. Two different double nitrites of palladium and potassium are usually formed in this reaction. Both are soluble and are precipitated in a crystalline form by alcohol from concentrated solutions. One of these salts has a deep orange-red color, the other is lemon-yellow; both are readily soluble in water, and alkaline sulphids precipitate palladium completely from the solutions.

These two salts were first described by Fischer.*

Rhodium.—When nitrite of potash is added to a solution containing the sesquichlorid of rhodium no change is at first produced, but on heating the solution becomes yellow, and on boiling or evaporation to dryness, part of the rhodium is precipitated in the form of a bright yellow or orange-yellow crystalline powder which is extremely insoluble in hot or cold water, but which dissolves readily in hot chlorhydric acid. Another portion of the rhodium usually remains in the form of a yellow salt soluble in water but insoluble in alcohol. The solutions of these two salts are decomposed with great difficulty by boiling with strong acids: alkaline sulphids give a dark brown precipitate of sulphid of rhodium soluble in a large excess of the precipitant and completely precipitated from the solutions by the addition of an excess of chlorhydric acid. Nitrite of soda also gives a soluble and an insoluble salt with solutions of rhodium, but only the soluble salt is formed when the rhodium solution is boiled for a short time with an excess of the alkaline nitrite.

The application of these facts to the separation of the several metals of the group is as follows:

Platinum from iridium.—The separation of platinum from iridium for the purpose of obtaining the two metals in a state of

* Pogg. Ann., lxxiv, 115.

chemical purity may be effected by either of the following processes. The iridium is in the first place to be brought into the form of bichlorid by means of a current of chlorine or by nitric acid, and the two metals are then to be precipitated together as $PtCl_2.KCl$ and $IrCl_2,KCl$, by the addition of a concentrated solution of chlorid of potassium. The color of the mixed salts varies from orange to almost black, according to the quantity of iridium present. The mass of crystals is to be rubbed fine in an unglazed porcelain mortar and boiling water added in the proportion of three volumes of water to one of salt. A dilute solution of nitrite of potash is then to be added, until the liquid becomes deep olive-green, carbonate of potash being thrown in from time to time in quantity sufficient to prevent the solution from becoming strongly acid. The iridium is instantly reduced to sesquichlorid, while the platinum salt remains as a reddish orange powder. The deep olive-green solution is to be poured off and the undissolved mass treated a second time with hot water and nitrite. This process must be repeated as long as the liquid remains olive-green. The mixed solutions on cooling, or after evaporation, deposit a beautiful mass of crystals of the double chlorid of potassium and iridium, $Ir_2Cl_3,3KCl+6HO$. By re-solution and repeated crystallization the iridium salt may be obtained perfectly free from platinum. Instead of nitrite of potash nitrite of soda may be employed in the above mentioned process; the iridium and sodium salt has the formula $Ir_2Cl_3, 3NaCl+24HO$, and crystallizes well. The undissolved mass and the mother liquors from the iridium salt contain a large quantity of platinum with a comparatively small quantity of iridium. When the absolute quantity of platinum salt is not very large it may be dissolved in boiling water, a small quantity of an alkaline nitrite added, and the solution allowed to crystallize; the resulting chlorplatinate of potassium contains only a trace of iridium.

The process just mentioned gives satisfactory results when carefully executed but requires attention to two points. In the first place the alkaline nitrite must be added in quantity just sufficient to reduce the iridium from bichlorid to sesquichlorid, but not so as to produce further chemical changes by the formation of the double nitrites of iridium and potassium or sodium. With a very little experience this is easily managed. In consequence of the facility with which the double nitrite of iridium and sodium is decomposed by boiling with chlorhydric acid into the double chlorid $IrCl_2,NaCl$, it is better to use nitrite of soda in the above process, because, in case an excess of nitrite is used, the mixed solution of double chlorid and double nitrite can easily be brought to the form of double chlorid, $Ir_2Cl_3,3NaCl$, by boiling with chlorhydric acid, neutralizing with carbonate of soda and then reducing the iridium to sesquichlorid by cautiously adding a very dilute solution of nitrite of soda.

In the second place it may happen, as in working with crude platinum solutions obtained, not from osmiridium, but from platinum ores, that the quantity of platinum is very large when compared with that of iridium. The process applies equally well to this case so far as the iridium is concerned, but it is difficult and troublesome to recrystallize large quantities of a salt so insoluble as the chlorplatinate of potassium, $PtCl_2,KCl$, and small quantities of the corresponding iridium salt are difficult to remove. A method of obtaining platinum in a state of chemical purity will be given further on.

The above process is capable of giving chemically pure iridium when platinum is the only other metal present. This is rarely the case and the following method is usually more advantageous. The greater part of the platinum is first to be separated in the manner above pointed out. The solution of double chlorid of iridium and sodium, $Ir_2Cl_3,3NaCl$, is then to be filtered, an excess of nitrite of soda added and the solution boiled until it assumes a clear orange-yellow color. To the boiling solution sulphid of sodium is to be added drop by drop as long as this produces a cloudiness and until a small quantity of the precipitated sulphid of platinum, PtS_2, is redissolved. Dilute chlorhydric acid is then to be added cautiously until the liquid, previously allowed to become cold, is distinctly though faintly acid, when it is to be filtered and the sulphid of platinum on the filter washed continuously with hot water. The filtrate is then to be boiled with chlorhydric acid in excess, and the resulting chloro-iridate of sodium evaporated, precipitated by a cold and strong solution of chlorid of ammonium, and washed with the same. This salt on ignition yields pure iridium, if the operation has been well conducted. It is in all cases however well, after separating the sulphid of platinum by filtration, to neutralize the filtrate with carbonate of soda, boil a second time with a little additional nitrite of soda and then add sulphid of sodium and proceed as before. In this manner every trace of platinum is removed and the resulting iridium salt is chemically pure.

Platinum from ruthenium.—Ruthenium in the form of bichlorid may be approximately separated from platinum by precipitating the two metals together in the form of $PtCl_2,KCl$, and $RuCl_2,KCl$, and washing out the ruthenium salt with cold water in which it is readily soluble. The mixed solutions should be evaporated to dryness with an excess of the alkaline chlorid and the dry mass rubbed to fine powder in a mortar, after which almost the whole of the ruthenium may be washed out with water or with a cold and moderately strong solution of chlorid of potassium. The undissolved platinum salt may then be purified by crystallization but usually retains traces of ruthenium. The rose-red solution of the ruthenium salt contains a small quantity of platinum from which it cannot be wholly freed by the difference in solubility of the two salts. Chlorid of ammonium may be employed in this process in place of chlorid of potassium.

To obtain a complete separation the following process may be followed with advantage. The chloro-ruthenate of potassium, separated as far as possible from the platinum salt, is to be heated with a solution of nitrite of potash in quantity sufficient to convert the whole of the ruthenium into the soluble yellow double nitrite of ruthenium and potassium, carbonate of potash being added in small quantities so as to keep the solution neutral or alkaline. The yellow or orange solution is to be evaporated to dryness in a water bath, the dry mass reduced to powder and boiled with absolute alcohol until the ruthenium salt is completely dissolved. This is best effected in a flask furnished with a condensing tube bent upward so that the alcohol vapors may be condensed and flow back into the flask. The boiling need not be continued for a very long time as the ruthenium salt is readily soluble in alcohol. The solution is then to be filtered off from the undissolved salts and these are to be washed with absolute alcohol until the washings are colorless, or until they no longer give the characteristic ruthenium reaction with sulphid of ammonium. The filtrate and washings may then be distilled to separate and save the alcohol, water being first added in small quantity. The residue in the retort or flask is then to be evaporated with chlorhydric acid which readily decomposes the double nitrite and yields a fine deep rose-red solution of the chloro-ruthenate of potassium, containing at most only a trace of platinum. The mass of salts undissolved by the alcohol contains nearly all the platinum in the form of chlorplatinate of potassium which is easily separated. The solution of chloro-ruthenate of potassium is now so pure that it gives the reactions of a chemically pure salt. To obtain the ruthenium in a state of absolute purity the solution is to be evaporated to dryness with a saturated solution of sal-ammoniac in excess, redissolved, again evaporated and the dry mass washed with a little cold water to remove the alkaline chlorids. The chloro-ruthenate of potassium is in this manner, for the most part at least, converted into chloro-ruthenate of ammonium. This salt is then to be dissolved in hot water, a solution of ammonia added, and the liquid boiled until it assumes a clear yellow or orange-yellow color, after which it is to be evaporated to dryness upon a water-bath. In this manner the ruthenium is converted into the chlorid of ruthen-diamin, $2NH_3,RuCl+3HO$, discovered by Claus. The yellow mass is to be dissolved in boiling water and a solution of chlorid of mercury added. A beautiful yellow crystalline double salt is precipitated, and the mother liquor, when cold, contains only traces of ruthenium and platinum. The double chlorid of mercury and ruthen-diamin has the formula $2NH_3,RuCl+HgCl$; it is almost insoluble in cold water, but is soluble in boiling water and is easily rendered absolutely pure by recrystallization. On ignition this salt yields chemically pure metallic ruthenium as a silver-white porous mass. When, in a mixture of solutions of ruthenium and platinum, the ruthenium is present either partly or wholly as sesquichlorid, the liquid is to be boiled with nitrite and carbonate of potash as above, evaporated to dryness, boiled with excess of chlorhydric acid to convert the double nitrite of ruthenium and potassium into chloro-ruthenate of potassium, $RuCl_2,KCl$, and the resulting solution treated by the process already described.

Platinum from rhodium.—The separation of these metals may be approximately effected by bringing the platinum into the form of $PtCl_2,KCl$ or $PtCl_2,NH_4Cl$, and the rhodium into that of $Rh_2Cl_3,3KCl$, or $Rh_2Cl_3,3NH_4Cl$, and then carefully washing out the rhodium salt by small successive portions of cold water, or better of a moderately concentrated solution of chlorid of potassium or ammonium. This is the method usually employed. By recrystallizing the platinum and rhodium salts respectively they may be obtained in a state of purity, since they are not isomorphous. To obtain rhodium absolutely free from platinum it is best to convert the two metals into the ammonium double salts, separate the rhodium salt as completely as possible by washing with a solution of sal-ammoniac and then evaporate the double chlorid of rhodium and ammonium with a solution of ammonia. In this manner the rhodium is converted into the chlorid of the ammonia-rhodium base discovered by Claus, $5NH_3,Rh_2Cl_3$, while the platinum forms no well defined or crystallizable compound. The chlorid of Claus's base may then be purified by repeated crystallization.

Iridium from ruthenium.—The separation of these metals cannot be effected by igniting them with a mixture of saltpeter and caustic potash. Under these circumstances the ruthenium is oxydized to ruthenate of potash, but a portion of the iridium also becomes soluble in the alkali, though in what state of oxydation it is difficult to ascertain. Moreover the complete oxydation of a mixture of the two metals, even when in a finely divided state, can hardly be effected by a single fusion. Claus has given no general method for the separation of iridium and ruthenium in the wet way. In his method of treating the Siberian ores the greater part of the rutheninm is separated as ruthenate of potash by the primary fusion with saltpeter and caustic potash, but a portion always remains with the iridium and is difficult to remove, especially as, after solution in chlorhydric acid, salts of both sesquichlorid and bichlorid of ruthenium are invariably present. No part of the present investigation has cost more labor than the complete separation of iridium and ruthenium, the properties of mixtures of the salts of these metals having sometimes almost led to a conviction of the existence of new metallic elements in the osmiridium.

A perfect separation of ruthenium from iridium may be easily effected by the following process which is applicable to all cases, without reference to the state of oxydation in which either metal may exist. To the solution containing the two metals nitrite of soda is to be added in excess, together with a sufficient quantity of carbonate of soda to keep the liquid neutral or alkaline. The whole is to be boiled until the solution assumes a clear orange-yellow or orange color. If a green tint should be perceptible more nitrite of soda must be added and the solution again boiled. Both ruthenium and iridium are converted into soluble double nitrites. A solution of sulphid of sodium is then to be added in small quantities at a time until a little of the precipitated sulphid of ruthenium is dissolved in the excess of alkaline sulphid. The first addition of the sulphid gives the characteristic crimson tint due to the presence of ruthenium, but this quickly disappears and gives place to a bright chocolate-colored precipitate. The solution is then to be boiled for a few minutes, allowed to become perfectly cold, and then dilute chlorhydric acid added cautiously until the dissolved sulphid of ruthenium is precipitated and the reaction is just perceptibly acid. The solution is then to be filtered through a double filter, and the sulphid of ruthenium washed continuously and thoroughly with boiling water. The filtrate is perfectly free from ruthenium: it is to be evaporated with chlorhydric acid and treated with sal-ammoniac in the manner already pointed out in speaking of the separation of iridium from platinum. The washed sulphid of ruthenium is to be treated together with the filter with strong chlorhydric acid and chlorid of ammonium added in quantity sufficient to form chloro-ruthenate of ammonium. Nitric acid is to be added from time to time in small quantities until, with the aid of heat, the whole of the sulphid of ruthenium is oxydized and dissolved. The liquid is then to be filtered, the filter well washed and the filtrate and washings evaporated to dryness on a water-bath, when, after washing out the soluble salt with a strong solution of chlorid of ammonium the salt, $RuCl_2,NH_4Cl$, remains almost chemically pure. It is to be dissolved and converted into the compound of chlorid of mercury and ruthen-diamin, $2NH_3RuCl+HgCl$, by the process already described. From this salt chemically pure ruthenium may be obtained by ignition, which is best effected in an atmosphere of hydrogen, as the reduced metal is easily oxydized in the air.

It may happen that the precipitated sulphid of ruthenium contains traces of iridium. This can only arise from imperfect washing or want of proper care in precipitating with sulphid of sodium. In this case the washings from the chloro-ruthenate of ammonium are yellow and contain sulphate of iridium, probably $Ir_2O_3, 3SO_3$. The quantity of iridium in such cases is too small to be worth the trouble of separate treatment.

When a solution contains iridium and ruthenium in the form of bichlorids, the ruthenium may be easily and completely separated by boiling the solution with nitrite of potash in excess, adding at the same time enough carbonate of potash to give an alkaline reaction, evaporating to dryness and dissolving out the double nitrite of ruthenium and potassium by means of absolute alcohol, in the manner recommended for the separation of ruthenium from platinum. The undissolved mass in this case contains the two double nitrites of iridium and potassium. By adding a strong solution of chlorid of ammonium, evaporating to dryness, igniting the dry mass in a porcelain crucible, and dissolving out the soluble salts, metallic iridium remains in a state of purity. This method may be used for the quantitative separation of iridium from ruthenium, but when the object is simply to prepare both metals in a state of chemical purity I prefer the separation by means of sulphid of sodium.

Iridium from rhodium.—Iridium may be approximately separated from rhodium by the process recommended by Claus, which consists in taking advantage of the solubility of the double chlorid of rhodium and ammonium, $Rh_2Cl_3,3NH_4Cl$, in moderately strong solutions of chlorid of ammonium in which chloro-iridate of ammonium is nearly insoluble. This method is difficult of application when the quantity of rhodium is small, and is at best tedious and unsatisfactory. A better method is that given above for the separation of iridium from ruthenium. The mixed solutions of iridium and rhodium are to be treated as above mentioned with nitrite of soda, the rhodium precipitated by sulphid of sodium in slight excess, the liquid rendered slightly acid, filtered and the dark brown sulphid of rhodium thoroughly washed. The filtrate is perfectly free from rhodium and is to be treated in the manner already described. The sulphid of rhodium is to be oxydized in the same manner as the sulphid of ruthenium and converted into the double chlorid of rhodium and ammonium, $Rh_2Cl_3,3NH_4Cl$, which is insoluble in a cold saturated solution of sal-ammoniac, in which it may be washed once or twice to remove alkaline salts and any traces of iridium which may be present as sulphate. The rhodium salt is then to be purified by crystallization, or converted into the chlorid of Claus's rhodium-ammonia base by evaporation on a water-bath with a solution of ammonia. The sulphate of iridium, $Ir_2O_3,3SO_3$, does not give a basic compound under these circumstances. The chlorid $5NH_3$, Rh_2Cl_3, is then to be further purified by crystallization.

Rhodium from ruthenium.—The separation of rhodium from ruthenium is best effected by means of nitrite of potash. The mixed solution of the two metals is to be boiled for a short time with an excess of the nitrite together with a little carbonate of potash to keep the solution neutral or slightly alkaline. The yellow or orange-yellow solution is then to be evaporated to dryness upon a water bath, the dry mass rubbed to fine powder and then treated in a flask with absolute alcohol in the manner pointed out for the separation of platinum from ruthenium. After filtration and washing with absolute alcohol, the rhodium remains undissolved in the form of a mixture of the two double nitrites of rhodium and potassium. These may be ignited with a large excess of sal-ammoniac so as to yield, after washing, metallic rhodium, or the nitrites may be dissolved in hot chlorhydric acid, ammonia added, and the rhodium precipitated as sulphid, which is then treated in the manner already pointed out, so as to convert the rhodium into the double chlorid of rhodium and ammonium. To remove the last traces of ruthenium the rhodium salt may be a second time treated with nitrite of potash, as above, and again washed with alcohol. The presence of the least trace of ruthenium is easily detected by adding a drop of colorless sulphid of ammonium to the alcoholic solution. The method of obtaining pure ruthenium from the double nitrite of ruthenium and potassium has already been given.

For the separation of osmium from the other metals of the group I have no better method to offer than that which is universally employed, namely, the volatilization of the osmium in the form of osmic acid. The separation of palladium is in all cases also best effected by the processes commonly employed, especially by taking advantage of the solubility of the double salts of protochlorid of palladium in solutions of the alkaline chlorids.

With these preliminary and general statements the method which I employ in separating the different metals of the platinum group from each other will be intelligible. The mass of double chlorids, obtained as already mentioned, is to be rubbed to a fine powder; introduced into a deep porcelain evaporating dish and mixed with four or five times its volume of boiling water. A solution of nitrite of soda is then to be added in small quantities at a time, the solution being continually stirred and occasionally neutralized by addition of carbonate of soda. The liquid soon becomes olive-green and the greater part of the mass dissolves: it is advantageous, when the quantity of the mixed chlorids is large, to pour off the liquid as soon as it appears saturated and to repeat the operation with a fresh quantity of water.

The undissolved mass, which consists chiefly of the impurities of the ore, when these have not been removed before the process of oxydation, is then to be thrown upon a filter and washed with boiling water until the washings are colorless. By keeping the solution somewhat alkaline the whole of the iron remains upon the filter as sesquioxyd with the other impurities. The filtrate contains iridium and rhodium as sesquichlorids, ruthenium partly as bichlorid and partly as protochlorid, platinum as bichlorid. When the operations already mentioned have been well performed, no determinable quantities of osmium and palladium are present. On cooling the greater part of the platinum is deposited as $PtCl_2,KCl$, mixed with a little of the corresponding iridium salt, and is to be separated by pouring off the olive-green supernatant liquid. The quantity of the alkaline nitrite to be added in this process need not exceed half of the weight of the mass of double chlorids, but with a little experience it will be found unnecessary to weigh the nitrite added, the process of the reduction of the iridum salt, $IrCl_2KCl$, being evident to the eye.

To the filtrate a solution of nitrite of soda is to be added and the whole boiled until the liquid assumes a clear orange color. Nitrite of soda should be used in this process because the resulting double nitrite of iridium and soda is easily decomposed by boiling with chlorhydric acid, which is not the case with the potash salt. When nitrite of potash is used a small quantity of the white insoluble double salt already mentioned is usually formed and renders the solution turbid.

To the clear yellow or orange-yellow boiling solution sulphid of sodium is to be added until a portion of the dark brown precipitate of the sulphids of ruthenium, rhodium and platinum is dissolved with a brown-yellow color, and an excess of the alkaline sulphid is consequently present. The liquid is then to be allowed to cool and treated with dilute chlorhydric acid until a distinctly acid reaction is produced. In this manner the whole of the platinum, ruthenium and rhodium present in the solution are thrown down as insoluble sulphids. After complete subsidence the sulphids are to be thrown on a double filter and thoroughly and continuously washed with boiling water. When the operation is carefully performed the filtrate and washings contain only iridium. It is best to neutralize this solution with carbonate of soda, boil a second time with a little additional nitrite of soda and treat as before with sulphid of sodium and chlorhydric acid. In this manner very small additional quantities of the sulphids of platinum, ruthenium and rhodium may sometimes be separated.

The filtrate is to be evaporated and boiled with an excess of strong chlorhydric acid which completely decomposes the double nitrite of iridium and soda, yielding the salt, $IrCl_2$,NaCl, which is very soluble in water. An excess of a pure and strong solution of chlorid of ammonium is then to be added, the whole evaporated to dryness, and the dry mass washed with cold water and then with a cold and strong solution of the ammonium salt. There remains a mass of pure chloro-iridate of ammonium which may be advantageously rubbed to a fine powder, dissolved in boiling water and allowed to crystallize. The resulting salt is chemically pure and the crystals possess an extraordinary beauty and lustre. The mass of mixed sulphids together with the filter are to be treated with strong chlorhydric acid, and nitric acid added in small portions at a time. By the aid of a gentle heat the sulphids are readily oxydized and dissolved. After sufficient dilution the liquid is to be filtered, the pulp of undestroyed filter paper washed, the filtrate evaporated to dryness, the dry mass digested with concentrated chlorhydric acid and again evaporated to dryness. The dry mass of chlorids and sulphates is to be redissolved in water and the platinum, ruthenium and rhodium precipitated by metallic zinc, after addition of chlorhydric acid. The finely divided metals after filtration washing and drying, are then to be mixed with chlorid of potassium and treated with dry chlorine at a low red heat. In this manner the metals are again brought into the form of double chlorids and the difficulties which arise from the presence of the sulphates are avoided.

The mixed double chlorids are to be boiled with nitrite of potash, evaporated to dryness, and the soluble nitrite of ruthenium and potassium dissolved out with absolute alcohol in the manner described in speaking of the separation of platinum from ruthenium. The ruthenium may then be obtained pure by converting it into the double chlorid of mercury and ruthendiamin already mentioned.

The mass undissolved by alcohol consists of chlorplatinate of potassium mixed with both the soluble and the insoluble double nitrites of rhodium and potassium. It is to be boiled with dilute chlorhydric acid, neutralized with carbonate of potash, again evaporated to dryness, after the addition of nitrite of potash, and again boiled with absolute alcohol which sometimes dissolves a trace of ruthenium. The undissolved mass is then to be treated with hot water and again evaporated to dryness, and this process repeated two or three times so as to convert the whole of the soluble rhodium salt into the insoluble salt. The chlorplatinate of potassium may then, after reducing the mass to fine powder, be dissolved out by boiling water, when the rhodium salt remains pure as a fine orange-yellow crystalline powder. This may be dissolved in hot chlorhydric acid, evaporated to dryness with an excess of pure chlorid of ammonium and ignited in a clean porcelain crucible, when pure metallic rhodium remains as a porous mass mixed with chlorid of potassium.

When the process above described has been carefully conducted, and especially when the quantity of nitrite of soda added is sufficient, the mixed sulphids will be found to contain only platinum, rhodium and ruthenium, and to be free from iridium. If however, after converting the sulphids into double chlorids in the manner pointed out, iridium is found to be present, the process to be pursued is still the same so far as regards the separation of the ruthenium; the remaining mass is then to be dissolved in water with addition of chlorhydric acid, the solution nearly neutralized with ammonia, the platinum and rhodium separated as sulphids in the manner already pointed out, brought into the form of double chlorids and then separated by nitrite of potash as before.

For the complete success of this method it is absolutely necessary that the mass of mixed double chlorids be freed from osmium as completely as possible. This is to be done in the usual manner by repeated evaporation with nitro-muriatic acid.

In place of the method above given the following may also be employed with success and are sometimes more convenient.

(To be continued).

Art. XXXI.—*Geographical Notices.* No. XVIII.

RETURN OF HALL'S ARCTIC EXPEDITION.

The latest, it is doubtful whether we can say the last, of the Arctic explorers has safely returned to this country. We learn that at an early day he is to present the results of his explorations in a paper to be read before the American Geographical Society, which will undoubtedly be printed. Meanwhile, we owe the following sketch of his journey to one of his advisers and friends, a public spirited gentleman in New London.

It may be recollected that in the year 1860, Mr. C. F. Hall, of Cincinnati, planned and started an expedition, on a plan somewhat novel, for the purpose of exploring the regions north and west of Hudson's Straits, in British America, and to discover if possible further relics and remains of the lost and mourned Sir John Franklin and his crews.

The peculiarity of Mr. Hall's efforts were that dispensing with vessels, men, provisions, fuel, &c., he proposed a journey over the trackless snow-fields *alone*, or with companions found among the roving Esquimeaux, whose habits and mode of life he proposed to adopt to the extent that should render him as independent as they.

Aided by a few friends, supplied with a boat, a few necessary scientific instruments, guns and ammunition, he sailed as passenger in the whaling Bark George Henry, of New London, Ct., June 29, 1860, for the scene of his labors.

The vessel in which he took passage prosecuted her voyage on the west side of Davis Straits, and remained during her stay in a small bay situated in N. lat. 62° 52′, W. long. 65° 05′. From this point Mr. Hall proposed, on starting, a journey far west, but owing to the accidental loss of his boat and the death of an intelligent interpreter, the original plan was abandoned, and he confined his researches to the country adjacent—going over and minutely examining an area of some three hundred miles west, and about seventy-five miles south from the place of starting. This area of country so far as our knowledge extends has not been seen or examined by any white man since the years 1573–6.

Hakluyt's Voyages, published in London in the year 1600, gives an account of the voyages of Sir Martin Frobisher to these regions where he discovered a Strait bearing his name and attempted to found a colony. An examination of the English Admiralty Chart of 1853, sheet one, or the fine American Chart from the United States Hydrographic Office, published with the volume of the Grinnell Arctic Expedition under Lieut. DeHaven, will show in faint outline the so-called Frobisher's Straits, supposed to afford a passage from the ocean westward to the further part of Hudson's Straits. Navigators however have always chosen the latter in passing to and from Hudson's Bay and vicinity, and it may be well that they have done so, for the travels of Mr. Hall have proved this to be not a strait but a bay or inlet, similar to Cumberland Inlet, just north on the same coast. This Frobisher's Bay, as we must now call it, is a noble sheet of water. Mr. Hall, with dog-team sledges in winter and boats in summer, coasted the entire circuit of it, examining every nook and corner, finding the main headlands and islands of the eastmost part to correspond with the descriptions of the ancient navigator; he found also indubitable proofs of the temporary settlement of the whites nearly three hundred years ago, and heard among the Esquimeaux well authenticated traditions of their attempt and its failure.

The entrance to this bay is just north of Resolution Island, at the mouth of Hudson's Straits,—a large island nearly blocks the passage, but once past this it stretches away west-northwest about two hundred miles, with an average width of about fifty miles. Numerous islands stud the coasts; an immense glacier is on the southern side, a mountain full of fossils at the western extremity, and bones of the whale and walrus bleach on the dark rocks up and down the shores. The waters and adjacent land abound with animal life—bears, deer, rabbits, ducks, birds, whale, walrus, seal and fish are numerous in their seasons. The native inhabitants from long distances resort here to fish and hunt, and all things considered it may be called a favored locality for such dreary regions—for about eight months of the year ice and snow are masters of the field.

Mr. Hall spent about twenty months in and about this region. He brings home a carefully prepared chart showing his discoveries and travels, also many relics and curiosities of the country. He has learned the Esquimeaux language and formed many friends among this simple-hearted and generous people. He proposes, by a volume or public lectures, to give the details and incidents of his journey, some of which have a romantic and thrilling interest.

Mr. Hall proposes to prosecute another voyage northward. By perseverance and pluck he has accomplished much that may prove of interest to the cause of science. Such energy should meet a suitable reward. R. H. C.

Anniversary of the Royal Geographical Society.—At this meeting, held in May last, the retiring President, Lord Ashburton, delivered an address, from which we make several extracts, containing more full and exact information than has reached us from any other source. Sir R. I. Murchison succeeds Lord Ashburton as President.

The Founder's Gold Medal was awarded to the representative of Richard O'Hara Burke, in remembrance of that gallant explorer, who with his companion Wills perished after having traversed Australia from south to north. A gold watch was also awarded to Mr. John King, the sole survivor of the expedition under Burke. The Patron's Gold Medal was awarded to Capt. Blakiston, R. A., for the survey of the River Yang-tze-Kiang, from Yo-chow to Ping-shan, extending nine hundred miles beyond the farthest point previously reached by Englishmen. We quote the following information from the address.

1. Ordnance Survey of Great Britain and Ireland.—The publication of 'The Trigonometrical Survey of the United Kingdom' is now completed, and is comprised in seven quarto volumes, viz.:—

I. The Principal Triangulation, with the Figure, Dimensions, and Mean Specific Gravity of the Earth derived therefrom, 2 vols.

II. Levelling, taken in Ireland, 1 vol.

III. Levelling, taken in England and Wales, 2 vols.

IV. Levelling, taken in Scotland, 2 vols.

Thus this great work, which was commenced in 1783, under General Roy, R.E., is at length finished.

In last year's estimates the sum of 1000*l.* was taken to enable the director of the survey to extend the triangulation of England through France to the frontiers of Belgium, so as to form a connection between the triangulations of England and Belgium. This operation has been completed. The stations selected to form the connection across the Channel were St. Peter's Church, between Margate and Ramsgate; Coldham, on the high ground north of Folkestone; and Fairlight, a few miles north of Hastings. From these three stations observations were taken to the church at Gravelines, to Mont Couple, near Wissant, and Mont Lambert, near Boulogne.

From these three last named stations a station raised 74 feet above the level of the ground at Harlettes, between Boulogne and St. Omer, was observed, and then the churches at Cassel and Dunkirk, and then the station at Mont Kemmel, near Ypres, in Belgium. The triangle, Dunkirk, Cassel, and Mont Kemmel, is common to the triangulations of France and Belgium, and is now also made part of the extended triangulation of this country, and the lengths of its sides will therefore be independently determined by the geometricians of the three countries from the measured bases in the three countries, and a comparison of the results will be highly interesting; but the French officers who were ordered to observe at the same stations that ours were observed at, not having been able last year to take the observations across the Channel, the comparison cannot yet be made. They have now, however, returned to this country to recommence their work, and it is to be hoped they will be able to finish it this summer.

During last year the Belgian geometricians were engaged in connecting their triangulations with that of Prussia, and the Prussians in connecting theirs with that of Russia; and thus we shall shortly have a connected triangulation, extending from the west of Ireland to the Oural mountains, and the means of computing the length of an arc of parallel of about 75° in length.

The electric telegraph now furnishes the means by which the difference of longitude between distant places can be determined with greater precision than they could formerly be by the transmission of chronometers from one station to another.

The Astronomer Royal will therefore this year re-determine the difference of longitude between Valentia, in the S.W. of Ireland, and the observatory at Greenwich, by means of the electric telegraph; and as it will be necessary for the director of the survey to connect the station selected by the Astronomer Royal at Valentia with the triangulation of the kingdom, a joint expedition is now about to proceed to Valentia for this double purpose, and to complete the quota of work assigned to us for the measurement of this great arc of parallel.

The engraving of the complete map of Ireland in outline, on the scale of one inch to a mile, was finished last year, and the hill features are now being engraved. There are 205 sheets in this map.

The progress of the Cadastral Survey in the north of England and Scotland has been greatly retarded in consequence of the very numerous and extensive surveys which have been made by the Ordnance in the south of England for the purposes connected with the defenses of the kingdom.

But as all these have been made on the scales adopted for the National Survey, and the plans have been drawn as so many sheets of a complete survey of the counties to which the places belong, they will form a part of the Cadastral Survey of England and Wales, should such a measure be decided on; and as the committee of the House of Commons, of which Lord Bury was chairman, which was appointed last year to report upon "the expediency of extending the Cadastral Survey to those portions of the United Kingdom which have been surveyed upon the scale of one inch to a mile only," have reported in favor of it, the cost of the surveys made for the defenses will go to diminish the cost of the Cadastral Survey.

In the north of England, Yorkshire and Lancashire have been published on the 6-inch scale; Westmoreland and Durham on the 25-inch scale; and the survey is in progress in Northumberland and Cumberland. A large portion of each of these counties has already been published, and they will be finished this year. The last sheets of the 1-inch map of England and Wales are in the hands of the engravers; we may, therefore, expect that this map, which was begun in 1784, will now be soon finished. In Scotland all the southern counties have been published either on the 25-inch or 6-inch scales; and the counties of Forfar, Perth, Stirling, and Dumbarton are in course of publication; and the survey is proceeding in Perthshire, Kincardineshire, and Buteshire. The 1-inch map of Scotland is also in course of publication.

The plans of the eight northern counties of Ireland have been revised and made perfect in every detail, like the plans of the southern counties. This perfect revision was rendered necessary to enable the Government valuators to mark upon the plans every property and tenement: and this has now been done throughout the whole of Ireland. The Ordnance plans are now invariably used for the transfer of land under the Landed Estates Court, the cost of preparing the plans for the court being charged to the carriage of the sale of the property; and the same arrangement will doubtless be introduced here as soon as some progress is made in the Cadastral Survey.

Sir Henry James has this year published six sheets of the Marginal Lines for the sheets of a map of the whole world, on the scale of 2 inches to a mile; the object in view being to have a map constructed on the largest scale required for geographical purposes, the sheets of which can be put together to form a connected map of any part of the world, however large or however small; and to avoid the confusion arising when we attempt to put together maps of different countries, as they are now constructed on different scales and on different projections.

This is a great undertaking, and one which will require the coöperation of a great number of people and some years to accomplish; but the advantages to be derived from having such a grand map of the world are obvious; and it is right that the topographical department of such a country as ours should undertake to make it.

In a discussion upon the relative merits of several projections for large portions of the earth's surface which has been published in the last number of the 'Philosophical Magazine,' it has been demonstrated, that, assuming the errors which all projections of a spherical surface on a plane must necessarily have, viz., distortion in form and distortion in area, are equally objectionable, the distance of the point of projection adopted by Sir Henry James in his geometrical projection of two-thirds of the sphere, will, for the projection of a hemisphere, give the least possible distortion of form and area, and that the misrepresentation will be a minimum. If we draw a circle and two diameters in it at right angles to each other, one may be taken to represent the plane of projection for the concave hemisphere above it, and the point of sight or projection is at the distance of half the radius in the prolongation of the other beyond its circle. It is now demonstrated that this is the best possible projection for a hemisphere, and it should therefore be adopted by all geographers.

2. Topographical Survey of Spain.—We learn from our correspondent, M. Coello, the accomplished geographer, who is now directing the topographical survey of Spain, that the following additions to our science have recently been made.

During the year 1861 persevering progress has been made in the great triangulation of the country.

All the chains of the triangles of the first order have already been studied, including those which relate to the whole circumference of the kingdom.

The chains of the meridian of Madrid, both to the north and to the south of that capital, have nearly all been measured, and will be completed before the end of the present year.

The parallel of Madrid to the west has been finished as far as the frontier of Portugal; and the measurement of the triangles of the parallel of Ciudad Real to Badajoz has been commenced. The triangles required to complete the spaces to the west of the meridian of Madrid have been laid down as far as that of Salamanca.

The triangulation of the second order is finished for the whole province of Madrid, as well as that for a part of the adjacent country. We are now only waiting for the results of the last calculations for compensation, which have just been completed, in order to fix the length of the great base of Madridejos, and begin the long calculation of the work which has been done.

This year these different undertakings will be continued, and signals will be fixed for the measurement of the parallel to the east of Madrid, with the intention of making, concurrently with this work, simultaneous and reciprocal observations to determine the geodistic level, and settle with accuracy the elevation of Madrid above the Mediterranean, presumed at present upon the most received existing calculations to be 660 mètres, which is, perhaps, within ten inches of the truth.

The topographical labors thus undertaken in the province of Madrid will be continued during the year. The corresponding land registration will at the same time be proceeded with, and the levels will be very carefully taken.

The maps are on the scale of $\frac{1}{1000}$, and of $\frac{1}{500}$ for cities and buildings. The classifications, territorial valuations, and dispositions in the public archive, will commence as soon as a portion of the province is completed. The topography is executed with very great accuracy.

During the past year a portion of the Tagus, and its tributary the Gallo, has been mapped to form a portion of the hydrography of Spain.

The geological department has completed its work in the provinces of Burgos, Santander, and Madrid, and has commenced with those of Leon, Zamora, and Avita.

In the department of Woods and Forests various topographical details have been obtained in the provinces of Santander, Burgos, Valencia, Asturias, Oviedo, and Leon.

All these works have been executed under the direction of the Funta-General of Estadistica, who is appointed by the Government to take charge of scientific researches regarding the Spanish territory.

3. Khanikoff's Researches in Persia.—The Russian traveller, N. de Khanikoff, who has been engaged in making up the deficiencies in our imperfect knowledge of the Aderbeijan, in Persia, has made a new map of that region, which he has had engraved at Berlin. He has distributed several copies of it, and transmitted his observations regarding that interesting mountain district to the Academy of Sciences in Paris, and also to our secretary, Dr. Shaw, for the use of the Royal Geographical Society.

An uncommon degree of regularity characterizes the mountain-ranges of this province of Persia, which is bounded both on the east and on the west by lofty longitudinal ridges. To the east the Talish mountains separate it from the basin of the Caspian; and to the west the chain of Kandilar forms a barrier between it and Mesopotamia. To the north and to the south of the Aderbeijan these two chains are joined by longitudinal elevations: the one, commencing at Mount Savalan (of 4752 mètres), joins the Kandilan chain in Kurdistan: the other, coming off from the Talish mountains, and known as the Buzgush chain, joins Mount Sehend (of 3505 mètres). The space included between Mount Savalan and the Talish chain of mountains is occupied by the plain of Mughan, and the Salt Lake of Urmia is situated in the region lying between the Sehend and the Kandilan chain. The lowest point of this part of Persia, that is to say, the level of the Lake of Urmia, is 1250 mètres above the level of the sea; and the highest point in the province of Aderbeijan is the summit of Ararat, 5169 mètres high. The line of perpetual snow varies in elevation from 3600 to 3800 mètres. This regular arrangement of the surface of the district, and the character of the climate, dependent on its high position, are very favorable for topographical work. The state of the atmosphere is generally so clear that one is never long without being able to see some one of the lofty summits which serve as landmarks for reference; and it rarely happens that mirage or dry fog interrupts the distinct vision of objects for an entire day. Notwithstanding the precision with which the skillful topographers from amongst the officers of the Caucasus who acted under his orders, as well as himself, endeavored to execute the work of laying down the itineraries of detached regions, it would be impossible to combine these independent labors without the basis of some well-determined astronomical geometrical observations. These happily were not wanting, as he had latitudes and longitudes in Persia which had been settled by M. Lemm, and the results of the triangulation of the Caucasus under the direction of Gen. Chosdzko. The former gave a series of fixed points in the neighborhood of the Araxes; and the latter supplied the like data, rigorously established, between Erivan and the basin of the Caspian. Hence the localities given in the north and middle of Khanikoff's map have their exact bearings; and it is only in the south that he had no other data than such as were obtained by azimuths measured with the help of the magnetic needle. The errors to which such observations are necessarily liable will be corrected when the Anglo-Russian commission for defining the Turkish and Russian boundary shall have published its numerous astronomic data.

That part of the map which is strictly new is the southern portion, in which is situated the Lake Urmia, with its islands; the itinerary from Marand to Khoi: and the topographical details in the two provinces of Persian Kurdistan, Lahijan and Ushnu, in which he had the good fortune to complete the researches of his predecessors, Generals Monteith and Rawlinson.

4. Various recent English Surveys in China.—Geography is already beginning to share in the advantages derivable from Lord Elgin's treaty, the conditions of which so greatly improve the position of the foreigner in China, whether traveller or official, merchant or missionary. Until that treaty came into operation, our countrymen could only penetrate the interior of this vast country in the face of legal prohibitions, and with the liability of arrest at the hands of the native authorities. The new treaty gives British subjects the right of travelling with a passport through the whole land, and so readily has this permission been availed of, that, in the first year after this right was obtained, twelve out of the eighteen provinces of China have been visited by our countrymen, together with Manchoo Tartary, the cradle of the present dynasty.

First among these explorations comes the ascent of the Yang-tze-Kiang, so gallantly undertaken by Colonel Sarel, Captain Blakiston, Dr. Barton, and Mr. Schereshefsky, the details of which are familiar to us all; while the high sense entertained by this Society of the services these gentlemen have rendered to geography has been marked, as you have seen this day, by the presentation of the Patron's Medal to Captain Blakiston. In tracing the great Yang-tze along 1800 miles of its course, those travellers crossed the six central provinces of Keangsoo, Nganhwuy, Keangse, Hoopih, Hoonan, and Sze-chuen; and thus carried their explorations upwards of a thousand miles beyond any point that had previously been openly visited by foreign travellers. The first 700 miles of that river's course is now made familiar to Europeans by the opening of the port of Hankow to foreign commerce, and there is every prospect of the high expectations that have been formed of the capacity of that great central mart being fully realized. Within eight months of the opening of that port it had been visited by nearly 200 foreign craft, consisting for the most part of small steamers; and the foreign trade thus conducted amounted during the first six months to two millions sterling.

Some particulars of no less than seven other journeys, undertaken by our countrymen in the north, centre, and south of China during the past year, have been made public. In the north, Mr. Morrison, our Consul at the new port of Chefoo, with Captain Harcourt as his companion, travelled over land to his post from Teentsin in the month of January, and profitted by the opportunity thus afforded him to follow the Grand Canal along nearly 300 miles of its track, to visit the tomb of the great sage Confucius, which is to be seen at Kewfoo, in the charge of his own descendants, a family with a pedigree of 2500 years, dating from the time of the sage himself. Mr. Morrison also visited Tsenan, the capital, and other places in the hitherto unexplored province of Shantung, and the journey took these travellers over 700 miles of country, for the most part new to Europeans. Six months later, two other foreigners set out in an opposite direction, and travelled overland from Teentsin to Moukden, the capital of Manchoo Tartary. They were struck by the manner in which this once Tartar country has been virtually converted into a Chinese province by the superior energy of the Chinese emigrants, and report that the Manchoos, even in this their native land, have lost their ground entirely in all parts of the country where anything is to be made by agriculture and commerce; and that those who remain, by adopting Chinese manners, customs, and *language*, have become, to all intents and purposes, Chinese, and have been absorbed into the predominant race. Later in the year, in November and December, an expedition through the two northern provinces of China, Pe-chih-le and Shan-se, was undertaken by Messrs. Richards and Slossin. Starting from the same point—Teentsin—they appear to have ascended the high plateaus to the north of Peking, and to have skirted the Mongolian steppes until they reached Shan-se. They travelled in this province as far as its capital Tai-yuen, and then, turning westward, re-entered Pe-chih-le, and visited Paou-king, the capital of the latter province, on their way back to Teentsin. The journey occupied the travellers 46 days, during which time they appear to have crossed the Great Wall four times, finding it in a state of decay that may be feared is typical of the country of which it is the chief monument, and they estimate the total length of their journey at 1560 English miles. The flourishing and populous condition of most of the country through which they passed accounts for the success of the new nothern port of Teentsin, the foreign trade of which, in the first year of its being opened, has reached the considerable sum of two millions sterling.

In the centre of China, four gentlemen—Messrs. Dickson, Thorburn, Beach, and Bonney—travelled, in the month of April, from Canton to Hankow, a distance of 756 miles, which they performed in 18 days; their journey differing from those above recited as being made entirely by water, with the exception of one day's land travel across the mountain-range that divides the province of Kwangtung from Hoo-nan. Following the course of the north river in the first-named province, and the Seang river in the latter, they thus traversed both those provinces from south to north, and were the first modern explorers of the great Tung-ting lake, by which they reached the Yang-tze and Hankow. In Cheh-kiang, Mr. Baker, having recently ascended the Tseentang river, and visited the celebrated green-tea districts of Nganhwuy, has again gone over ground previously travelled by Mr. Fortune, but to find in this instance that the previous prosperous condition of those important tea districts has disappeared before the rebel scourge, and that scenes of industry have been replaced by desolation and destruction.

In the south of China, the Rev. Dr. Legge was the first foreigner to ascend, in April of last year, the east river in the Kwangtung province to a distance of about 300 miles; and the Rev. Mr. Irwin and companions have penetrated up the west river, in the same province, to a somewhat higher point than that reached by the expedition under Captain McCleverty in the spring of 1859, for a description of which we are indebted to our associate Lieutenant Brine. The opening of Formosa to foreign trade gives promise also of our shortly obtaining further information from that island, which is interesting not only from its commercial productions, but also from the presence of aboriginal tribes in its centre and eastern coast, of which little is as yet known.

It is satisfactory to hear from all these travellers that no serious obstacles were placed in their way either by the Chinese authorities or the people; and that, while inconvenienced at times by the not unnatural curiosity of the latter, when anxious to gaze on foreigners for the first time, they received from them, in most cases, friendly welcome and assistance. Our treaty-right to enter the country having thus obtained an effectual recognition, it will be seen that China is now thrown open to the researches of the traveller, subject, however, to the difficulties arising out of the deplorable disorders which are at present rife in so many of its provinces. Different parties of rebels or robbers, all acting independently of each other, were met by Colonel Sarel's party in Sze-chuen, by Mr. Morrison in Shantung, by Mr. Baker in Chehkeang, and by Mr. Irwin in Kwangtung; while Dr. Dickson's party, on the other hand, travelled from Canton to Hankow—or from the south to the centre of China—without falling in with any of these destructive hordes; and Messrs. Richards and Slossin traversed the provinces of Shan-se and Pe-chih-le under similar favorable circumstances.

Measurement of a Peak in the Karakorum range, second in height to Mount Everest.—The Journal of the Asiatic Society of Bengal (xxix, p. 20), contains a statement respecting the survey of Kashmir, by Capt. Montgomerie of the Topographical Survey of India. After referring to the fact that the peak Nanga Parbut, having a height of 26,629 feet, had been regarded as king of the Northern Himalayas, as Mount Everest, having a height of 29,002 feet, is king of the southern Himalayas, —the writer, Maj. Thuillier, Dep. Surveyor General, announces the measurement of a new snowy peak, termed for the present K. 2, on the Karakorum range, which is probably the second highest known mountain in the world. He writes as follows:

"The party under Captain Montgomerie is now engaged in Thibet. The country is exceedingly difficult and the strength of the party much diminished. In the progress of the survey advantage has been taken of the opportunity to extend accurate geographical knowledge by fixing numerous peaks in the Karakorum and Mustag ranges. One of those already determined on the Karakorum range, along which runs the boundary between Ladakh and Yarkund, one hundred and fifty-eight miles N.E. of Srinagar, is 28,278 feet high (provisionally settled only, being liable to a small correction when the levelling operations from the sea level at Karachi, now in progress, are completed). None of the peaks in the neighborhood of K. 2 come nearly up to it though there is one fine group about sixteen miles away that is generally a little over twenty-six thousand. This is probably the second highest mountain in the world, as it exceeds Kanchinginga by 122 feet, but is lower than Mount Everest by 724 feet, as measured by the Surveyor General in 1847.*

It is expected that Captain Montgomerie will be able to fix points up to 36° 30′ N. latitude, but it is doubtful whether he will be able to get in all the Topography quite as far as that, in consequence of the wild and Yághi state of some of the people."

A sketch showing the position of this mountain, and its environs, is given in Petermann's Mittheilungen, 1861, p. i.

Fiji Islands.—The British Government have lately had under consideration a project for making the Fiji Islands a dependency of the British Crown. An expedition was sent to the islands under Col. Smythe, R.A., to investigate the circumstances under which the proposal was made. Dr. Seemann, a member of the Commission, has given the following Report to the Royal Geographical Society:

* * * "The islands are now visited by traders from many nations; and the object of their inhabitants in appealing to England, was to extricate themselves from political embarrassments which were becoming fastened upon them.

The report of the Commission was favorable to the bonâ fide nature of the proposal and also to the value of the islands as fertile, healthy, and convenient stopping places for the traffic to Australia by way of Panama. The question of the acceptance of their sovereignty was under the consideration of the British Government.

The Fiji group owe their origin to a volcanic upraising and to the growth of corals; the islands are usually hilly, and present an unbroken mass of trees on their southern side, while their northern slopes are grassy and watered by streams descending from the central highlands, whose ridges condense the vapor of the trade-winds.

A great variety of vegetation is found in the islands: its predominant appearance is tropical. The mangrove-swamps are confined to the deltas of the rivers, and the islands are singularly exempt from malignant fever.

Their fertility may be estimated from the fact that, though partially and imperfectly cultivated, they support a population of 200,000, and supply provisions to foreign vessels and yield an immense export of cocoanut-oil, obtained by a wasteful process. Their fertility appears still more remarkable on considering the variety of their vegetable productions useful to man. Sugar, coffee, tamarinds, and tobacco are cultivated with success; so are four oil-yielding and five starch-yielding plants; four different spices; twelve edible roots; eleven potherbs; thirty-six edible fruits; and a vast number of medicinal, fibrous, scent-yielding, and ornamental plants, besides a long list of first-class timber-trees. It was the abundance of sandal-wood that first attracted Europeans to their shores.

* See Geog. Not., V, this Jour., [2], xxvii, 62.

They promise an excellent field for the best qualities of cotton; the undulating ground, the neighborhood of the sea, and the absence of frost being cogent reasons in favor of its growth: the inhabitants are also beginning to work for wages. Experiments in raising cotton have already been tried with remarkable success, both by Dr. Seemann and by others.

Dr. Seemann bears witness to the laudable influence of the Wesleyan missionaries over the islanders, who recently were savage cannibals. He considers the religion which Christianity is beginning to supplant, as well worthy of philosophical study. Their belief is in a Supreme Deity, and in future rewards and punishments. They worship their ancestors. The chiefs are a taller, better developed, and in every respect a more able caste of men than the rest; it follows from this that mere height of stature in a stranger is an important claim upon the consideration of the islanders."

ART. XXXII.—*Contributions from the Sheffield Laboratory of Yale College.* — IV. *Observations on Caesium and Rubidium;* by OSCAR D. ALLEN, Ph.B., Assistant in the Sheffield Laboratory.

THE discovery of the presence of the new elements rubidium and caesium in several varieties of European lepidolite, made it a subject of interesting inquiry to ascertain whether American lepidolite would not also serve as a source for these rare metals.

A preliminary experiment made last autumn by Mr. John M. Blake and myself, having shown that the lepidolite from Hebron in Maine contains these alkalies in comparative abundance, I was led to visit that locality, and there obtained the material which served for the following investigation.

Lepidolite occurs at Hebron in large quantity, in a coarsely crystalline granite, associated with red and green tourmaline and albite. It has a granular, and at the same time foliated, crystalline structure, a pale rose to violet color, and very closely resembles the lepidolite of Penig in Saxony, and like that is also associated with the rare species amblygonite.* This locality is only eight miles from that in Paris, which has long been known to mineralogists.

Preparation of the salts of Caesium and Rubidium from the Hebron Lepidolite.—The process used for decomposing this mineral was based upon that employed by Prof. J. Lawrence Smith for the determination of alkalies in silicates. Ten parts of the pulverized lepidolite were first mixed with forty parts of coarsely powdered quicklime; a mixture of enough water to slake the quicklime, with hydrochloric acid sufficient to form from six to

* This Journal, [2], xxxiv, 243.

seven parts of chlorid of calcium was next made ready; the two mixtures were then united, and stirred vigorously during the process of slaking, thus intimately blending the mineral with suitable proportions of dry hydrate of lime, and chlorid of calcium.

It was found by experiment that practically as good results were obtained when the lepidolite was powdered sufficiently fine to pass a sieve of 20 holes to the linear inch, as when it was more finely pulverized, the fact being that the foliated structure of the mineral exposes a large surface to the decomposing agency of the lime mixture.

The mixture was heated to redness for six to eight hours in hessian crucibles. Care was taken to avoid a heat much above redness, as otherwise alkali-chlorids volatilize in dense clouds, and the mass fusing, is absorbed to a considerable extent into the crucible and lost. The long duration of the ignition was a matter of convenience, due to the character of the furnace employed, and probably not necessary to the decomposition of the mineral.

The agglomerated product obtained from the ignition of this mixture was detached from the crucibles and boiled with water a quarter to half an hour, and leached till all but a trace of the chlorids was removed. The solution thus procured, containing chlorid of calcium and the chlorids of the alkali-metals, was evaporated till crystals began to form, then sulphuric acid was added as long as sulphate of lime separated, taking care to avoid an excess, and the whole mass was evaporated to dryness, and strongly heated to expel free hydrochloric acid. The residue was treated with water, and the small quantity of sulphate of lime which went into solution, was precipitated by carbonate of ammonia, the filtered solution was again evaporated to dryness and ignited.

Ten and a half kilogrammes of lepidolite treated in this way afforded 2169 grammes of salts consisting of chlorids, with a small admixture of sulphates, of sodium, lithium, potassium, rubidium and caesium. This quantity of salts subjected to Bunsen's process of fractional precipitation with bichlorid of platinum, furnished 132 grammes of the platinchlorids of caesium and rubidium in which no potassium could be detected with the spectroscope. The platinchlorids were very gently heated in a current of hydrogen gas until complete reduction of the platinum took place, and the chlorids were then extracted with water.

The per-centages of caesium and rubidium obtained from the mineral by this process were calculated from the amount of chlorine contained in these mixed chlorids.

0·5825 grm. dissolved in water and precipitated with nitrate of silver gave 0·5835 grm. of chlorid of silver, which represents 0·1439 grm. of chlorine.

These numbers furnish the following equations:

$$(1) \quad Rb + Cs = 0{\cdot}5825 - 0{\cdot}1439$$

$$(2) \quad \frac{Rb}{85{\cdot}36^*} + \frac{Cs}{123{\cdot}35^*} = \frac{0{\cdot}1439}{35{\cdot}5}$$

which give Cs=0·3002 and Rb=0·1384. According to these proportions the 132 grammes of platinchlorids contained 31·1969 grammes of caesium, 14·3826 grammes of rubidium, which numbers respectively correspond to 0·3 per cent and 0·14 per cent of the mineral employed.

It appears therefore that it is practicable to extract almost one half per cent of the two metals from the Hebron lepidolite, even when operating on a large scale, and in a somewhat crude manner. In separating the platinchlorids of caesium and rubidium from the platinchlorid of potassium, a not inconsiderable amount of these metals went into solution with the potassium salt, thus materially diminishing the quantity obtained. Much the larger proportion of this loss was rubidium, due to the greater solubility of its platinchlorid. On comparing these results with Cooper's analyses† of the Rozena lepidolite, it appears that although not quite so rich in rubidium, the Hebron mineral is remarkably rich in caesium. The lepidolite from Rozena and Zinnwald contain, according to the published analyses, only an unweighable trace of caesium, while that from Hebron contains more than three-tenths of one per cent.

Experiments in separating Caesium and Rubidium.—The process described by Bunsen for separating the new alkalies appeared to be so troublesome, requiring for the preparation of pure rubidium salts 20 to 30 extractions of the carbonates with boiling absolute alcohol (*Ann. Chem. u. Phar.*, cxxii, 353) that I have made various attempts to discover a simpler method.

In the first place a trial was made with the picrates of the new metals. To a concentrated solution of their mixed chlorids an alcoholic solution of picric acid was added. The liquid immediately filled with fine acicular crystals. These were rinsed with water and successively recrystallized from fresh portions of water eleven times. Portions of the 1st, 2d, 3d, 4th, 7th, and 11th crops of crystals were separately examined in the spectroscope, the picrates being converted into chlorids for this purpose, by treatment with aqua regia. No difference being observable between the spectra of the various crops, no further experiments were made in this direction. It may be here remarked that the mixed picrates crystallize with great facility in needles an inch in length, and perfectly resemble the corresponding potassium salt.

* Combining proportions of caesium and rubidium determined by Bunsen.—*Pogg. Ann.*, cxiii, 339.

† *Jour. prakt. Chem.*, lxxxv, 125.

A second series of trials was made with the platinbromids of potassium, rubidium and caesium. The platinbromid of potassium is known to be readily soluble in water. The platinbromids of caesium and rubidium readily separate from dilute solutions of these three metals, but carry down potassium with them. For the removal of the latter metal from the new alkalies the platinbromids appear to have no advantage over the platinchlorids, while they are equally inadequate to the separation of caesium and rubidium from each other. In external characters the three platinbromids closely resemble each other.

Finally, recourse was had to the bitartrates, and with satisfactory results. Carbonates of caesium and rubidium were first prepared from the chlorids by converting them into sulphates, separating the sulphuric acid with caustic baryta, and removing the excess of baryta by carbonic acid. To the alkaline solution thus obtained, twice as much tartaric acid was added as was necessary to neutralize it. This solution was concentrated till it was nearly saturated at 100° C. The crystals which deposited on cooling when examined by the spectroscope, showed the rubidium lines more intensely than did the original mixture, while the caesium lines were much fainter. This product was dissolved and recrystallized from hot saturated solutions three times. The caesium reaction in these successive crops diminished until in the fourth it disappeared, leaving the rubidium spectrum in entire purity.

In order to ascertain whether the more soluble bitartrate of caesium could be purified from rubidium by fractional crystallization, the solution from which the first crystals had been removed was concentrated to nearly one-half its original volume, when by cooling, a very small quantity of salts of the two alkalies was deposited. This operation was repeated three times, when a portion of the solution evaporated to dryness, and examined by the spectroscope gave only the lines belonging to caesium. The several intermediate products containing both alkalies were then united and another portion of each salt separated from them in the same manner. By repeating this process of fractional crystallization four times with about 40 grammes of the mixed salts, 23·77 grammes of bitartrate of caesium, and 12·511 grammes of bitartrate of rubidium were obtained, while 3·74 grammes remained unseparated. It was found that the caesium salt thus obtained, although exhibiting no impurity when tested by the spectroscope directly, i. e. after conversion by ignition into carbonate, was still mixed with a trace of rubidium, as on converting it into chlorid, a faint line characteristic of the latter metal was perceptible. The separation of two or three more small crops of crystals sufficed to render the residual solution perfectly free from any admixture that could be detected by a spectroscope of ordinary power.* The rubidium salt was also more carefully tested in the same manner, but was found to be entirely pure.

The process above described thus furnishes a simple and easy method of separating in a perfectly pure state a large share (in these trials about 90 per cent) of a mixture of the two alkalies. It requires no great expenditure of time, since the solutions employed can be concentrated at high temperatures, and on cooling immediately deposit well formed crystals.

Composition and solubility of the Bitartrates of Caesium and Rubidium.—Bitartrate of rubidium crystallizes from hot solutions in colorless transparent flattened prisms, which are often half an inch or more in length, even when formed rapidly from small quantities of solution. They remain unaltered in the air and also are unchanged at a temperature of 100° C. The pulverized salt dried at 100° C. was burned with chromate of lead in the usual manner.

I. 0·4681 grm. gave $\begin{cases} 0{\cdot}0902 \text{ grm. water, and} \\ 0{\cdot}354 \quad \text{" carbonic acid.} \end{cases}$

To determine the base, the salt was heated to a temperature a little below redness, the resulting carbonate extracted with water from a small residue of carbon which could not be burned away without volatilizing rubidium. The carbonate was then converted into chlorid, fused and weighed without exposure to the air.

II. 1·3772 grm. gave 0·7149 grm. chlorid of rubidium.

In the following statement these results are reduced to per cents, and compared with the calculated composition of bitartrate of rubidium as expressed by the formula

$$\left.\begin{matrix} C_8\,H_4\,O_8 \\ H\;\;Rb \end{matrix}\right\} O_4$$

	Calculated.		Found. I.	Found. II.
C_8	48·00	20·48	20·62	....
H_5	5·00	2·13	2·17	....
O_{11}	88·00	37·55	....	....
RbO	93·36	39·84	....	40·09
	234·36	100·00		

The solubility of this salt in hot and cold water was determined by evaporating on the water-bath, solutions saturated at the given temperatures and weighing the residues.

I. 11·9254 grammes of solution saturated at the boiling point, gave a residue of 1·2555 grammes.

* The instrument used was a modification of Bunsen and Kirchhoff's spectroscope, devised by Prof. J. P. Cooke, and manufactured by Messrs. Alvan Clark & Sons of Cambridgeport.

One part of the salt accordingly requires 8·5 parts of boiling water for solution.

II. 17·535 grms. of solution saturated at 25° C. gave a residue of 0·205 grm.

III. 16·094 grms. of solution saturated at 25° C. gave a residue of 0·188 grm.

One part of the salt thus required respectively 84·53, and 84·6 parts of water at 25° C. for solution.

The *bitartrate of caesium* forms crystals closely resembling the rubidium salt, but in my experiments they were usually of smaller size.

The salt obtained by concentrating the solution from which all the rubidium had been separated, was to all appearance pure. It was recrystallized, and after drying at 100° C., at which temperature it suffered no loss of weight, was analyzed in the same manner as the bitartrate of rubidium.

I. 0·4718 grm. gave $\begin{cases} \text{0·0786 grm. water, and} \\ \text{0·294 " carbonic acid.} \end{cases}$

II. 0·5966 grm. gave $\begin{cases} \text{0·101 grm. water, and} \\ \text{0·372 " carbonic acid.} \end{cases}$

III. 1·3086 grm. gave 0·7708 grm. chlorid of caesium.

Assuming the combining proportion of caesium to be 123·35, as determined by Bunsen, the following statement exhibits the composition of the salt, according to the formula,

$$\left.\begin{matrix} C_8\,H_4\,O_8 \\ H\ \ Cs \end{matrix}\right\} O_4$$

	Calculated.		Found. I.	Found. II.	Found. III.
C_8	48·00	17·62	16·99	17·02	....
H_5	5·00	1·83	1·85	1·88	....
O_{11}	88·00	32·31	....	....	....
CsO	231·35	48·24	....	....	48·70
	272·35	100·00			

The discrepancy between the composition as calculated and found is perhaps due to a slight admixture of the neutral tartrate which might possibly have been present, owing to the use of insufficient tartaric acid.

The solubility of bitartrate of caesium was determined for the same temperature and by the same methods as were employed in case of the rubidium salt.

I. 2·998 grms. of solution saturated at the boiling point gave a residue of 1·483 grms.

One part of the salt requires 1·02 part of boiling water for solution.

II. 11·931 grms. of solution saturated at 25° C. gave a residue of 1·054 grms.

III. 8·7625 grms. of saturated solution at 25° C. gave a residue of 0·7727 grm.

One part of the salt accordingly requires 10·32 parts of water at 25° C. for solution.

The fact that bitartrate of rubidium requires about eight times as much water for solution as bitartrate of caesium, explains the facility with which these salts can be separated from each other by crystallization.

In these experiments I have received the advice and assistance of Profs. Johnson and Brush, for which I here take pleasure in expressing my most grateful acknowledgments.

New Haven, Aug. 12th, 1862.

Note.—Since the above was written I have recovered from the mother-liquors and washings of the 132 grms. platinchlorids of caesium and rubidium first obtained, an additional quantity of potash-free platinchlorids (chiefly of rubidium) amounting to 40 grms., making the total yield 172 grms. from 10½ kilogrammes of lepidolite. Most of this remained in solution from the use of insufficient bichlorid of platinum in some of the precipitations. The content of rubidium in the Hebron lepidolite thus appears to be not less than in that from Rozena. O. D. A.

Art. XXXIII.—*Abstract of an investigation of the solar diurnal variation and of the annual inequality of the Horizontal Component of the Magnetic Force, from observations made at the Girard College Observatory, between* 1840 *and* 1845; by A. D. Bache, LL.D., F.R.S., Sup't U. S. Coast Survey.

Part V.—*Of the discussion of Magnetic and Meteorological Observations made at Girard College, Philadelphia.*

The previous discussion (Part IV) (p. 261) of the observations of the horizontal force, furnishes the materials from which the investigation of the diurnal and annual variation of the horizontal force is made. The monthly normal values for each hour of observation were corrected for temperature and for irregularity in the progressive change, and freed from the influence of the larger disturbances. The monthly normals of the five years' series are tabulated according to the months of the year and hour of the day and the method of interpolation for omissions of observations and the like, explained in Part II, has been in general followed. The irregularities of the first month of observation were, however, such as to render it expedient to omit these results and to begin the year with July.

The several values of the monthly normals are taken from Table VII, Part IV, the correction shown in the remarks to Table V, Part IV, to be necessary, having been applied.

It will be recollected that the observations were made 21½ minutes after the hour of mean local time, counting from midnight to midnight. Increase of scale readings correspond to decrease of horizontal force. One scale division was equivalent to 365 ten millionths of the force, or, in absolute measure to 1524 ten millionths, the mean horizontal force being, in absolute measure 4·176. Proper weights, according to the number of observations were given to the results for the even and odd hours.

The tables given in the memoir contain the hourly normals for each month of the five years, and for the mean, reckoned in scale divisions, and reduced to the standard temperature of 63° Fahrenheit and corrected for irregularities in the progressive change. The numbers there contain the regular progressive and secular changes.

From these detailed tables are formed the following:—

TABLE No. I.—*Recapitulation of the hourly normals of the horizontal magnetic force, expressed in scale divisions. Increase of scale readings correspond to decrease of force. The observations were made 21½ minutes after the hours stated at the heads of the several columns.*

1840-45.		1	2	3	4	5	6	7	8	9	10	11h	+21½m
July,	681	679	677	675	673	668	664	673	686	692	694	690	
Aug.	698	699	699	698	699	695	693	702	714	724	726	718	
Sept.	720	718	720	718	714	713	711	721	735	744	749	746	
Oct.	735	731	731	727	725	728	729	734	739	746	751	750	
Nov.	739	738	736	734	733	730	728	732	737	743	746	751	
Dec.	772	767	766	764	761	759	756	758	761	766	775	783	
Jan.	794	792	792	790	788	787	786	784	786	795	802	808	
Feb.	800	798	796	796	795	793	791	793	795	800	808	810	
March,	803	802	801	800	799	797	795	799	804	812	817	822	
April,	824	823	823	820	818	817	817	820	829	841	849	851	
May.	834	833	830	829	829	826	824	829	838	846	847	843	
June,	858	858	858	858	855	852	849	855	861	867	869	866	
Year,	[illegible]1·5	7[illegible]9·8	769·1	76[illegible]·4	765·7	763·7	761·9	766·7	773·7	781·3	786·1	786·5	
Summer,	[illegible]69·2	768·3	767·8	7[illegible]6·3	764·7	761·8	759·7	766·7	777·2	785·7	789·0	785·7	
Winter,	[illegible]3·8	771·3	770·3	7[illegible]·5	766·8	765·7	764·2	766·7	770·3	77[illegible]·0	783·2	787·3	

1840-45.	12h (noon)	13	14	15	16	17	18	19	20	12	22	23h	+21½m
July,	683	672	663	660	659	666	675	677	679	681	682	683	
Aug.	708	698	689	688	69[illegible]	696	701	703	704	703	704	702	
Sept.	736	726	720	718	719	723	724	725	723	725	722	722	
Oct.	751	747	743	740	739	739	738	739	740	739	739	738	
Nov.	750	746	740	738	737	739	736	736	737	739	741	740	
Dec.	785	778	773	768	764	765	767	768	771	772	772	771	
Jan.	808	801	796	790	787	790	793	794	793	794	794	790	
Feb.	813	808	804	800	801	800	801	804	806	802	800	800	
March,	819	814	806	801	804	807	810	808	804	803	805	804	
April,	845	839	827	824	822	822	827	827	830	830	828	827	
May,	837	830	825	824	823	825	831	832	835	836	835	832	
June,	860	855	848	847	847	851	856	858	859	858	859	859	
Year,	782·9	776·[illegible]	[illegible]69·[illegible]	7[illegible]6·5	[illegible]66·2	768·6	771·6	772·6	773·4	773·5	773·4	772·8	
Summer,	778·[illegible]	770·[illegible]	[illegible]62·[illegible]	760·2	[illegible]60·3	763·8	769·0	770·3	771·7	772·2	771·7	770·8	
Winter,	787·7	782·[illegible]	777·[illegible]	772·8	772·0	773·3	774·2	774·8	775·2	774·8	775·2	774·8	

The following table contains the mean values of the normals for each month and season, reckoning as the summer season, the half year from April to September inclusive, and as the winter, the months from October to March inclusive.

TABLE No. II.

1840-44.	Normal.
July,	676·3
Aug.	702·2
Sept.	724·6
Oct.	738·2
Nov.	738·5
Dec.	768·4

1841-45.	Normal.
Jan.	793·3
Feb.	800·6
March,	805·7
April,	828·3
May,	832·2
June,	856·8

1840-45.	Normal.
Year,	772·1
Summer,	770·1
Winter,	774·1

To obtain the regular solar diurnal variation for each month and season of the year, we subtract the numbers in table I. from their respective monthly and season and yearly mean values given in table II. After converting these numbers into parts of the absolute horizontal force, table No. III. of the memoir shows the results, the significant numbers being expressed in units of the sixth place of decimals and the sign + indicating a value greater than the mean, and the sign − one less than the mean. Three decimals 0·000 are placed at the side of the table. This table is omitted in the present abstract.

Table No. IV. shows the results obtained in table III, converted into absolute measure by multiplying by 4·176 the absolute horizontal force. Two places of decimals 0·00 are placed at the side of the table and are to be understood as preceding each number.

The annual inequality in the daily variation of horizontal force as derived from table No. IV, is shown in diagram A. The annual mean shows a maximum value about 6 A. M., a minimum about 11 A. M., a secondary maximum about 3½ P. M. and a secondary minimum about 9 P. M. The maximum at 6 A. M. is stationary throughout the year. The morning minimum is lower during the summer when the sun's declination is north, and the afternoon maximum is higher, thus increasing the daily range. The converse takes place in winter. The average summer range is 0·0046, and the average winter range 0·0025. The average range between the morning maximum and the morning minimum in summer is 0·0045 and in winter 0·0036.

The half yearly change is better represented in the annexed diagram (B) derived from (A) by straightening out the annual curve and using it as an axis of abscissæ, upon which to lay off the differences between the values of the same hours for the year, and for the summer and winter. The comparison of this diagram with the corresponding one in Part II. for the annual change in the diurnal variation of the declination is of considerable interest.

At 6 A. M. there is scarcely any change during the year. The maximum change occurs about 9 A. M., the range being about

TABLE No. IV.

0·00	1840–45.	0^h	1	2	3	4	5	6	7	8	9	10	11^h	$+21\frac{1}{2}^m$
	July,	-071	-041	-010	+020	+050	+127	+188	+050	-147	-239	-270	-208	
	Aug.	+064	+048	+048	+064	+048	+109	+140	+003	-180	-332	-362	-242	
	Sept.	+070	+101	+070	+171	+162	+177	+201	+055	-159	-296	-372	-326	
	Oct.	+048	+109	+109	+100	+201	+155	+140	+064	-012	-119	-195	-180	
	Nov.	-008	+008	+038	+068	+083	+129	+160	+099	+022	-068	-114	-190	
	Dec.	-055	+021	+037	+067	+113	+143	+189	+159	+113	+037	-101	-223	
	Jan.	-010	+020	+020	+050	+081	+096	+111	+141	+111	-025	-132	-224	
	Feb.	+009	+040	+061	+070	+085	+116	+146	+116	+085	+009	-113	-143	
	March,	+041	+056	+071	+086	+102	+132	+163	+102	+025	-096	-172	-248	
	April,	+066	+081	+081	+127	+157	+172	+172	+127	-010	-193	-315	-346	
	May,	-027	-012	+033	+048	+048	+094	+125	+048	-088	-210	-226	-165	
	June,	-018	-018	-018	-018	+027	+073	+119	+027	-064	-155	-186	-140	
	Year,	+009	+034	+045	+071	+096	+127	+155	+083	-025	-141	-213	-220	
	Summer.	+014	+026	+034	+057	+082	+125	+157	+053	-108	-238	-289	-238	
	Winter.	+004	+042	+056	+086	+111	+129	+152	+114	-058	-044	-138	-201	

0·00	1840–45.	12^h (noon)	13	14	15	16	17	18	19	20	21	22	23^h	$+21\frac{1}{2}^m$
	July,	-102	+065	+203	+248	+263	+157	+020	-010	-041	-071	-102	-102	
	Aug.	-088	+064	+201	+216	+155	+094	+018	-012	-027	-012	-027	+003	
	Sept.	-174	-021	+070	+101	+085	+024	+009	-006	+024	-006	+040	+040	
	Oct.	-195	-134	-073	-027	-012	-012	+003	-012	-027	-012	-012	+003	
	Nov.	-175	-114	-022	+008	+022	-008	+038	+038	+022	-008	-038	-022	
	Dec.	-253	-146	-070	+006	+067	+052	+021	+006	-040	-055	-055	-040	
	Jan.	-224	-132	-041	+050	+096	+050	+005	-010	+005	-010	-010	-041	
	Feb.	-189	-113	-052	+009	-006	+009	-006	-052	-082	-021	+009	+009	
	March,	-203	-127	-005	+071	+025	-020	-065	-037	+025	+041	+010	+025	
	April,	-254	-163	+020	+065	+096	+096	+020	+020	-025	-025	+005	+020	
	May,	-073	+033	+109	+125	+140	+109	+018	+003	-043	-058	-043	+003	
	June,	-048	+027	+134	+149	+149	+088	+012	-018	-033	-018	-033	-033	
	Year,	-165	-063	+040	+085	+090	+053	+008	-008	-020	-021	-021	-011	
	Summer,	-123	+001	+123	+151	+148	+095	+015	-004	-024	-032	-027	-012	
	Winter,	-206	-128	-044	+020	+032	+012	-000	-011	-016	-011	-016	-010	

0·00194 in absolute measure. About $11\frac{1}{2}$ A. M. there is an epoch of no variation. At 2 P. M. a second maximum, about 0·00167 is reached. At $7\frac{1}{2}$ and 11 P. M. points of no change are reached.

To find the turning epochs of the annual variation, the monthly values for the hours of 9 A. M. and 2 P. M. when best developed were taken from table No. IV. and again compared with the annual mean as in the following table.

TABLE No. V.—*Annual variation at the hours of 9 A. M. and 2 P. M. compared with the annual mean.*

	9 A. M. 0·00	Diff. 0·00	2 P. M. 0·00	Diff. 0·00	Mean differ. 0·00
January,	-025	+116	-041	-081	+099
February,	+009	+150	-052	-092	+121
March,	-096	+045	-005	-045	+045
April,	-193	-052	+020	-020	-016
May,	-210	-069	+109	+069	-069
June,	-155	-014	+134	+094	-054
July,	-239	-098	+203	+163	-130
August,	-332	-191	+201	+161	-176
September,	-296	-155	+070	+030	-092
October,	-119	+022	-073	-113	+046
November,	-068	+073	-022	-062	+068
December,	+037	+178	-070	-110	+144
Mean,	-141		+040		

This table shows by the change of sign and progress of values, that the epoch of change occurs some time after the equinoxes, and that the maximum of variation is reached about the time of the solstices, a result which corresponds closely with that derived from the discussion of declination in Part II. Representing the average of the results for each half year by the usual analytical formula, we find that the change takes place about twenty-two days after the equinoxes which is about twelve days later than we found for the declination.

To obtain the best result from observations, the values of table No. I were thrown into the usual analytical form, equations for each month, for the half year, and for the year's results having been obtained. The analytical results for a determinate hour of any month differ but slightly from the observed results. For example the differences for August between the computed and observed results, differ in no case more than three scale divisions and generally range between 0 and 2. Diagrams (C) and (D) represent these results, the dots corresponding to the observed quantities and the curves to the results of analysis. The results for the summer months are given in diagram C, and those for the winter in diagram (D). The comparison of the two diagrams shows the much greater range of the variation of horizontal force when the sun is north of the equator, as was also found from the discussion of the magnetic declination.

Diagram (E) gives the curves of regular solar diurnal variation of the horizontal force for the summer, the winter, and for the whole year.

Table VIII, contains the computed values of the time and amount of the morning maximum and minimum and of the afternoon maximum. The values for the secondary afternoon minimum are taken from the diagrams. The time of the A. M. maximum and minimum is within the nearest eighth minute, that of the P. M. maximum within the nearest tenth minute, that for the P. M. secondary minimum within the nearest hour. The change of force is expressed in scale divisions.

The extreme variation in the epoch of the A. M. maximum is $2^h\,15^m$. The variations for the A. M. minimum is $1^h\,55^m$, for the P. M. maximum it is $2^h\,30^m$, and for the secondary afternoon minimum between three and four hours. In all cases the earlier hours occur in the summer season. Table IX shows the diurnal range, expressed in scale divisions, parts of the horizontal force and in absolute measure. In the second column the range between the A. M. maximum and minimum is given; in the third column that between the A. M. minimum and the P. M. maximum. These two amplitudes for A. M. and for A. M. and P. M., are further illustrated in diagram (F), which shows the curve to be double crested with maxima near the time of the equinoxes and the greater of these near the autumnal equinox.

TABLE No. VIII.

	Morning maximum.		Morning minimum.		Afternoon max.		Secondary Afternoon min.		Interval A. M. min. to P. M. max.
	h. m.	*d.*	*h. m.*	*d.*	*h. m.*	*d.*	*h.*	*d.*	*h. m.*
January,	7 10	− 9·2	11 50	+15·7	4 10	− 5·3	11	+2	4 20
Februry,	7 15	− 9·6	11 40	+12·7	4 00	− 0·9	7	+2	4 20
March,	6 15	− 9·2	11 30	+16·4	3 20	− 2·3	6	+3	3 50
April,	6 00	−12·3	11 20	+22·5	3 55	− 6·6	9	+3	4 35
May,	5 50	− 7·9	10 25	+15·5	3 10	− 9·8	9	+4	4 45
June,	5 50	− 6·3	10 30	+12·5	3 20	−10·4	8	+3	4 50
July,	5 35	− 9·9	10 30	+19·3	3 25	−17·5	9	+6	4 55
August,	5 55	− 8·5	10 10	+24·8	2 45	−14·2	9	+3	4 35
September.	5 35	−14·9	10 20	+25·9	3 05	− 6·7	7	−1	4 45
October.	5 00	−12·6	11 15	+13·7	5 10	− 0·1	9	+2	5 55
November,	6 00	− 9·8	11 25	+11·0	5 15	− 3·0	11	+0	5 50
December,	7 05	−12·1	12 05	+16·1	4 35	− 5·1	10	+4	4 30
Summer,	5 50	− 9·8	10 30	+19·6	3 25	−10·5	20½	+3	4 55
Winter,	6 15	− 9·4	11 45	+13·9	4 10	− 2·2	21	+2	4 25
Year.	5 55	− 9·6	11 00	+15·6	3 35	− 6·0	20¾	+2·5	4 35

TABLE IX.—*Amplitude of the diurnal variation of the horizontal force.*

	For A. M.	For A. M. & P. M.	For A. M.	For A. M. & P. M.	For A. M.	For A. M. & P. M.
	d.	*d.*				
Jan.,	24·9	21·0	0·00091	0·00077	0·0038	0·0032
Feb.,	22·3	13·6	081	050	34	21
March,	25·6	18·7	093	068	39	29
April,	34·8	29·1	127	106	53	45
May,	23·4	25·3	085	092	36	38
June,	18·8	22·9	069	084	29	35
July,	29·2	36·8	106	134	45	56
August,	33.3	39·0	122	142	51	59
Sept.,	40·8	32·6	149	119	62	50
Oct.,	26·3	13·6	096	050	40	21
Nov.,	20·8	14·0	076	051	32	21
Dec.,	28·2	21·2	0·00103	077	0·0043	0·0032
Summer,	29·4	30·1	0·00107	0·00110	0·0045	0·0046
Winter,	23·3	16·1	0·00085	0·00059	0·0036	0·0025
Year,	25·2	21·6	0·00092	0·00079	0·0038	0·0033
	In scale divisions.		In parts of the hor. force.		In absol. meas.	

The next table (X) contains the epochs when the mean horizontal force is reached in each day, as computed by the preceding formulæ. The diurnal curves intersect the axis of abscissæ four times, of which the table contains only the A. M. and first P. M. intersection, those later in the afternoon and near midnight occur in summer, winter and the whole year at 7 P. M., 5¾ P. M. and 6½ P. M. respectively, and at 11¼ P. M., 12 P. M., 11¾ P. M. respectively.

The above times are generally correct within 2 minutes (according to the formulæ). The morning hour of average daily horizontal force is less variable in the course of a year than the afternoon hour.

Diagram (G) exhibits the changes in the horizontal force in absolute measure from the monthly normal value for each hour of

TABLE X.—*Principal epochs of mean horizontal force.*

	A. M.	P. M.
January,	9h 20m	2h 36m
February,	9 23	2 58
March,	8 42	2 28
April,	8 14	2 19
May,	7 44	0 59
June,	7 47	0 48
July,	7 57	0 53
August,	7 28	0 44
September,	7 42	1 29
October,	8 08	5 00
November,	8 40	3 28
December,	9 34	3 03
Summer,	7 45	1 12
Winter,	9 00	3 07
Year,	8 14	1 54

the day and for each month of the year. The three variables are the hour of the day, the month of the year, and the difference of the horizontal force from the normal. The contour lines of the magnetic surface differ 0·0005 of horizontal force in absolute measure. Full lines indicate greater value, lines of dashes less value than the mean; dotted lines represent the normal value.

Annual variation of the horizontal force.—For the discussion of the annual variation we make use of monthly normal readings of the horizontal force as given in table No. II. If m equals the monthly effect of the total progressive change, we obtain from the twelve equations by the usual method the value $m = +15·49$, and the correction for progressive change for July and June for instance becomes $+5·5\,m$ and $-5·5\,m$ respectively. The following table contains the monthly normals uncorrected and corrected for progressive change, also the differences from the mean of each month constituting the annual variation.

TABLE XII.

	Normals.	Corr. for prog. change.	Corrected normals.	Differences or annual variation.		
					0·000	0·00
July,	676·3	+85·2	761·5	+10·6	+39	+16
August,	702·2	+69·7	771·9	+ 0·2	+01	+00
September,	724·6	+54·2	778·8	− 6·7	−24	−10
October,	738·2	+38·7	776·9	− 4·8	−17	−07
November,	738·5	+23·2	761·7	(+10·4)	(+38)	(+16)
December,	768·4	+ 7·7	776·1	− 4·0	−15	−06
January,	793·3	− 7·7	785·6	−13·5	−49	−20
February,	800·6	−23·2	777·4	− 5·3	−19	−08
March,	805·7	−38·7	767·0	+ 5·1	+19	+08
April,	828·3	−54·2	774·1	− 2·0	− 7	−03
May,	832·2	−69·7	762·5	+ 9·6	+35	+15
June,	856·8	−85·2	771·6	+ 0·5	+02	+01
Mean,	772·1	0·0	772·1	In scale divisions.	In parts of the horizon force.	In absol. measure.

With the exception of the month of November, the values given above for the annual variation are tolerably regular in their progression, and considering the delicacy of the test applied to the observations in deducing the annual variation, this exceptional irregularity in the November value will not affect the general conclusion. We have as the general results a greater horizontal force in summer (April to August), and a smaller horizontal force in winter (from September to March) than the average annual value. The maximum occurs in July (at Toronto in June) and the minimum in January (at Toronto in December).

For Toronto we have the expression for the annual variation,

$$3{\cdot}531+0{\cdot}002 \sin(\theta+306^\circ)$$

For Philadelphia: (omitting the November value),

$$4{\cdot}176+0{\cdot}001 \sin(\theta+312^\circ),$$

the angle θ, in both equations counting from Jan. 15th.

The annnal range is 0·0021 (in absolute measure) the transition appears to take place about the time of the equinoxes or a short time before.

Table XIII contains the monthly normal values of the horizontal force in absolute measure obtained by adding (algebraically) 4·1760 to the values in the last column of table XII. These numbers, it will be observed, are corrected for secular change; if we apply the same we obtain the resulting monthly mean values of the horizontal force answering to the epoch, January 1843. The quantity A, mentioned in the explanatory remarks to table No. VII, is given in the last column of table No. XIII.

TABLE No. XIII.

	Normals. Corr. for secular change.	Monthly means affected with sec. ch.
July, - -	4·1776	4·1787
August, - -	4·1760	4·1769
September, -	4·1750	4·1757
October, - -	4·1753	4·1758
November, -	4·1776	4·1779
December, -	4·1754	4·1755
January, - -	4·1740	4·1739
February, - -	4·1752	4·1749
March, - -	4·1768	4·1763
April, - -	4·1757	4·1750
May, - -	4·1775	4·1766
June, - -	4·1761	4·1750
Mean, - -	4·1760	4·1760

ART. XXXIV.—*Abstract of the investigation of the influence of the Moon, on the Horizontal Magnetic Force, from observations made at the Girard College Observatory, in the years* 1840–'41–'42–'43–'44–'45; by A. D. BACHE, LL.D., F.R.S., Sup't U. S. Coast Survey.

PART VI.—*Of the discussion of Magnetic and Meteorological Observations made at Girard College, Philadelphia.*

THE method pursued in the investigation of the lunar effect on the horizontal force is, in general, the same as that explained in Part III of the discussion of the Girard College observations. The process may be briefly recapitulated as follows. Each observation for horizontal force after being corrected for the effect of difference from the standard temperature, and for progressive change, the disturbed readings being omitted (as fully explained in Part IV), was marked with its corresponding lunar hour. The observation nearest to the time of the moon's upper transit over the true meridian of the observatory was marked 0^h; that nearest to the lower transit 12^h; and the observations between for western and eastern hour angles of the moon, were marked with the proper lunar hour by interpolation. In the hourly series when thirteen observations were recorded in twelve lunar hours, that observation which is nearest midway between any two consecutive lunar hours was omitted. Each observation and reduced reading thus marked with its corresponding lunar hour was subtracted from the monthly normal belonging to its respective hour, and these differences were set down in tabular form, arranged according to lunar hours and keeping each monthly result separate for future combination.

The greatest difference possible is 33, the number of scale divisions which, according to the criterion, separates a disturbed from an undisturbed observation. For the formation of these differences which amount to more than 22000, the manuscript tables of the reduced record were used. These tables have already been referred to in the preceding paper, Part IV.

The units in which the differences are expressed, are scale divisions, one division being equal to 0·0000365 parts of the horizontal force, or to 0·000152 in absolute measure, the mean X being equal to 4·176 (in units of grains and feet).

The lunar effect on terrestrial magnetism being very small the process required for its elucidation is proportionally delicate. All the regular and irregular deviations arising from other sources must first be eliminated. In the method as indicated above, the magnetic disturbances (as far as they could be recognized); the diurnal and annual solar variation, as well as the eleven (or ten) year inequality, and secular change, are all eliminated, leaving numbers fitted for the research of the lunar effect.

The readings taken in the month of June, 1840, have not been used in the discussion, nor in the two preceding parts, because of the imperfect manner in which the allowance for the progressive change could only be made at that time. For the lunar hour 21 in July, 1840, the number of differences is so small that the mean had necessarily to be reduced, and only one fourth of its amount was set down in the table. In January, February, and March, 1843, the observations were discontinued, excepting a single daily reading. Those months are therefore not included in the lunar discussion.

TABLE No. 8.—*Recapitulation of the annual means exhibiting the lunar diurnal variation from* 22045 *observations between* 1840 *and* 1845, *expressed in scale divisions.*

July to July.	U.Cul 0h	1	2	3	4	5	6	7	8	9	10	11h
1840–'41	−0·4	+0·5	+1·5	−0·3	−0·1	+0·3	−2·4	−1·3	−1·5	−0·2	+1·3	−0·1
1841–'42	+1·1	+2·0	+2·5	+0·9	+0·3	+1·1	+0·7	−1·1	−0·4	−1·3	−0·2	+1·0
1842–'43	+0·7	−0·9	−1·0	+2·9	+0·1	+1·6	+0·7	+1·9	−1·2	+0·7	−1·0	0·0
1843–'44	+0·9	+0·4	+0·8	+1·5	+0·9	−0·3	+0·4	+3·3	+0·1	−0·8	−1·2	−0·6
1844–'45	−0·9	+0·6	+0·5	+0·3	0·0	+0·6	+0·6	+0·9	+0·1	−0·3	0·0	+0·2
Mean,	+0·3	+0·5	+0·9	+1·1	+0·2	+0·7	0·0	+0·1	−0·6	−0·4	−0·2	+0·1
July to July.	L. Cul. 12h	13	14	15	16	17	18	19	20	21	22	23h
1840–'41	+1·0	+0·8	+0·1	+0·4	−0·2	+0·6	−2·3	−1·3	+0·6	−2·1	+0·6	+1·2
1841–'42	+1·2	−0·1	−0·2	−1·5	−0·6	−2·4	−1·1	−0·2	−0·3	−0·3	−1·0	+1·4
1842–'43	+0·1	+0·1	+1·4	−0·6	+0·8	−0·9	−1·9	+0·1	−0·3	−0·8	+0·9	0·0
1843–'44	+0·3	−0·2	+0·2	+0·3	+1·3	−0·6	−0·9	−0·7	−0·9	−0·8	0·0	−0·2
1844–'45	+1·0	+0·4	+0·5	0·0	−0·7	−0·1	−0·3	−0·8	−1·8	−1·2	−1·0	−1·6
Mean,	+0·7	+0·2	+0·4	−0·3	+0·1	−0·7	−1·3	−0·6	−0·5	−1·0	−0·1	+0·2

If we give weights to the annual means according to the number of observations, they would be one for the first and second years; three-fourths for the third year; one and three-fourths for the next year, and two for the last year. A general examination however shows that owing to the disturbing effect of the progressive change, the monthly means are very nearly of equal value, derived either from the bi-hourly or from the hourly series. It is also shown in the sequel that the lunar diurnal variation is nearly the same in the summer and winter seasons.

A comparison of the values of table No. VIII. among themselves, shows them to be very irregular, although derived from many thousand observations. A five year series of observations seems barely sufficient to exhibit a tolerably regular progression. In the following table two groups have been formed, one of results from three years, 1840 to 1843, comprising 8797 observations; the other from the remaining two years, comprising 13248 observations. From these it appears, that the lunar diurnal variation during these two periods exhibit the same general character.

Lunar Diurnal variation during the periods 1840–'43 *and* 1843–'45.

Groups.	0^h	1	2	3	4	5	6	7	8	9	10	11^h
1840–'43.	+0·5	+0·5	+1·0	+1·2	+0·1	+1·0	−0·3	−0·2	−1·0	−0·3	0·0	+0·3
1843–'45.	0·0	+0·5	+0·7	+0·9	+0·4	+0·3	+0·5	+0·6	+0·1	−0·6	−0·6	−0·2
Groups.	12^h	13	14	15	16	17	18	19	20	21	22	23^h
1840–'43.	+0·8	+0·3	+0·4	−0·6	0·0	−0·9	−1·8	−0·5	0·0	−1·2	+0·2	+0·9
1843–'45.	+0·7	+0·1	+0·4	+0·2	+0·3	−0·4	−0·6	−0·7	−1·3	−1·0	−0·5	−0·9

Before proceeding to the analysis of the final result of table No. 8, the separate results were combined into summer and winter groups, the first comprising the months from April to September, the second group the winter months from October to March.

The results are exhibited in the annexed diagram A. The number of observations, about eleven thousand for each group, is evidently too small to eliminate the greater irregularities.

If there is any marked difference in the lunar diurnal variation in the summer and winter season, the summer range is slightly greater than the winter range. As to the epoch there is no doubt that in winter the lunar maxima and minima are earlier than in summer. It is a remarkable fact that the same feature shows in the lunar effect on the declination, namely, a greater amplitude in summer and an earlier occurrence of the maxima and minima in winter. The amount of the shifting of the two curves seems to be nearly the same.

From the ten years series of observations at Prague (1840–'49), Mr. Karl Kreil found a larger lunar effect in summer months than in winter.

Recurring to the final values of the lunar diurnal variation of the horizontal force, as given in table No. 8, they can be represented by the usual Besselian form of periodic functions.

The curve is double crested and is exhibited together with the observed values in the annexed diagram. It presents two maxima and two minima. (See diagram B.)

The lunar effect on the declination we have found also to present two maxima and two minima as stated in Part III. of the discussion.

An examination of the diagram just referred to, shows;—

Principal maximum,	2^h 52^m	after upper culm.;	+0·78	scale divisions.
Secondary "	1 7	" lower " ;	+0·51	"
Principal minimum,	6 41	" " " ;	−0·87	"
Secondary "	8 19	" upper " ;	−0·45	"

The epoch of the horizontal force tide for the high values is nearly two hours after the culminations, and for the low values it is seven and a half hours after the same phases.

For Makerstoun in Scotland, at Sir Thomas M. Brisbane's observatory in 1843–'46, Mr. J. A. Broun found (Trans. Royal Soc. Edinburgh, vol. xix, p. 2, 1849) the smaller maximum of the horizontal force two hours after the upper culmination, the greater maximum an hour and a quarter after the lower culmination; the smaller minimum eight hours after the upper culmination, and the greater minimum nine hours after the lower culmination.

At Prague all extremes appear from two to three hours later. Mr. Kreil (Denkschriften of the Imp. Acad. of Sciences at Vienna, vol. v, 1853) found from the ten years series at Prague (1840–49) maxima of horizontal force between four and five hours after the upper an lower culminations, the latter being the greater of the two, and minima between ten and eleven hours after the same epochs, that after the upper culmination being the greater of the two.

From the Toronto observations Major General Sabine deduced a formula giving a curve of which the general features are in exact accordance with those deduced from the Philadelphia observations, namely, a principal maximum after upper culmination, followed by the secondary minimum; the secondary maximum after the lower culmination followed by the principal minimum. The times and amount of these values are compared in the following table (No. 10).

TABLE No. 10.—*Comparison of the lunar diurnal variation of the horizontal component of the magnetic force, as deduced from 22045 observations between 1840 and 1845 at Philadelphia, and as deduced from 34303 observations between 1844 and 1848 (a 5 year series) at Toronto, Canada.*

	Philadelphia.	Toronto.
Time of principal maximum,	$2^h.9$ after U. C.	3^h after U. C.
" " secondary minimum,	8 .3 " "	9 " "
" " secondary maximum,	1 .1 " L. C.	2 " L. C.
" " principal minimum,	6 .7 " "	8 " "
	In parts of the horizontal force.	
Amount of prin. max.	+0.000032	+0.000046
" " secon. min.	−0.000016	−0.000010
" " secon. max.	+0.000019	+0.000024
" " prin. min.	−0.000032	−0.000041
	In absolute measure.	
Amount of prin. max.	+0.000133	
" " secon. min.	−0.000068	
" " secon. max.	+0.000078	
" " prin. min.	−0.000133	

Probable error of any single representation of the Philadelphia values $=\pm 0{\cdot}25^{div} = \pm 0{\cdot}000009$ parts of the horizontal force $=\pm 0{\cdot}000038$ in absolute measure.

Investigation of the horizontal force in reference to the lunar places.

The following process of reduction has been adopted. After marking the days of the full and new moon and also the days preceding and following, the daily means of the horizontal force readings were taken (already corrected for difference of temperature and progressive change) for the place of any disturbed observation, the monthly normal, belonging to the respective hour, was substituted before taking the daily mean. All accidental omissions in the record of the hourly or bihourly series were supplied by the hourly normal of the month. The means thus obtained, are independent of the solar diurnal variation. The monthly normal was next compared with each daily mean and the differences (normal minus mean) were tabulated.

A positive sign signifies a greater, a negative sign a less force than the normal value. As the results deduced from a single year are yet too much affected by the incidental irregularities of the observations, the collective results from the five year series (1840–45) are herewith presented.

TABLE No. 11.—*Influence of the lunar phases on the horizontal force.*

	s d	Parts of the h f.	In absol. meas.
One day before full moon,	−1·0	−0·000036	−0·00015
On the day of " "	−1·5	−0·000055	−0·00023
One day after " "	−0·2	−0·000007	−0·00003
One day before new moon,	+0 0	+0·000000	+0·00000
On the day of " "	+2·4	+0·000091	+0 00038
One day after " "	+0 9	+0·000033	+0·00014
Difference for new-full moon,	3 9	0·000146	0·00061

The average number of observations from which any one of the above six means were deduced is over 800 and the probable error, in scale divisions, of any one of the results is $\pm 0{\cdot}7$ (nearly).

From the Makerstoun observations Broun found for the years 1843–46 a minimum at the time of the full moon and a maximum at the time of the new moon; Kreil, from the Prague observations, between 1843–46 found the same result as given above. It must be remarked, however, that after the year 1848, Kreil found that the signs were reversed, and consequently it appears that the lunar influence on the horizontal force is subject to a cycle of short period. This last remark does not apply to the effect of the moon's declination and variation in distance.

Influence of the moon's changes of declination on the horizontal force.

The method of investigation is precisely the same as that adopted for the phases. We find:

TABLE No. 12.

	s. d.	
One day before the greatest north declination,	+0·8	Mean +1·1.
On the day of " " " "	+0·6	
One day after " " " "	+2·2	
Two days after " " " "	+0·9	
On the day of the moon's crossing the equator,	−1·2	Probable error of any one result ±0·9.
One day before the greatest south declination,	−3·4	Mean −0·6.
On the day of " " " "	−0·9	
One day after " " " "	+0·9	
Two days after " " " "	+1·0	

It seems probable that the greatest effect takes place rather a day after than on the day of the moon's greatest declination. Taking means as indicated in the above table we find about the time of the maximum north declination an increase of horizontal force of 1·1 scale division (or 0 000040 parts of the horizontal force); at the time of the moon's crossing the equator the force is decreased 1·2 scale divisions (or 0·000044 parts of the horizontal force). The horizontal force also appears decreased about the time of the moon's greatest north declination, the amount is about half that of the other two cases and is somewhat doubtful, by an apparently excessive value on the preceding day.

According to Broun there is at Makerstoun a maximum horizontal force at the time of the moon's greatest north and south declination with a minimum force at the time of her crossing the equator; in two cases, therefore, viz: for north declination and no declination the Makerstoun and Philadelphia results agree, while in the third case they disagree or remain doubtful. Kreil's results, from the Prague observations, do not appear to me sufficiently decisive and regular to admit of comparison.

Influence of the moon's variation in distance on the horizontal force.

By a similar process of reduction as that followed in the preceding investigation we find

	s. d.	s. d.
One day before perigee,	−1·5	mean −1·8
On the day of "	−1·9	
One day after "	−2·0	
One day before apogee,	+2·3	mean +2·4.
On the day of "	+2·3	
One day after "	+2·7	

The probable error of any one result is about the same as in the preceding results (tables XI. and XII). The results for variation in the moon's distance are more consistent and satisfactory than those depending on the phases and declination changes. The lunar effect is to diminish the horizontal force by its 0·000066 part in perigee and to increase it by it 0·000088 part when she is in apogee.

The Prague results are the same, viz: a greater horizontal force at and after the moon's apogee than at and after her perigee; a three years series of observations at Milan, however, do not agree therewith. In no branch of magnetic research would additional results from independent observations, particularly at stations widely apart, be more acceptable and valuable than in the study of the lunar effect in its various manifestations.

ART. XXXV.—*On Arithmetical Relations between Chemical Equivalents;* by M. CAREY LEA, Philadelphia.

IN previous numbers of this Journal I have published a series of papers on this subject, one point of which has been subjected to criticism; namely, that I have introduced, in order to complete certain series, negative equivalents, as is alleged, without giving any explanation of such a conception.

In answer, I may observe, that I have not used the expression attributed to me. I have never once in the whole series of papers referred to, spoken of negative equivalents. Such an expression would I conceive, be an absurdity. Any negative quantity taken in an isolated sense is, as Carnot has proved, an absurdity. But I have pointed out that by carrying certain decreasing arithmetical series to successive terms, the equivalents of well marked series of chemical bodies were obtained, and that finally when we reached a point at which the last term was less than the common difference, the series might yet be continued, and the equivalents of other elements, admitted by all chemists to belong to the same natural group, might be obtained, although with negative signs affixed. For example, if commencing with antimony, we subtract a number corresponding nearly with 45 we obtain in succession the equivalents of arsenic and phosphorus. With phosphorus we reach a term, the numerical value of which is less than the common difference. We cannot therefore carry the series forward another term without encountering negative numbers. Nevertheless there remains another member of the group, nitrogen, intimately bound to it. Is it not then a matter of great interest to observe that this last member of the group, apparently cut off from it, is reached, although with a negative sign, by simply carrying the series another step?

There next arises the question "What signification is to be attached to a quantity presenting itself under these circumstances with a negative sign? I need not remark that the theory of negative signs has been a stumbling block in the way of mathematicians and has given rise to long disputes between men of the most exalted intelligence; such as those which occurred between Leibnitz and Bernouilli, and between Euler and D'Alembert.

But the ideas which prevail at the present day are sufficiently clear to throw a light on this subject, and I cannot do better than quote verbatim the following passage which I translate from Carnot.

"The true sense which is to be attached to this expression, (that of a negative quantity), is that this absolute quantity does not belong to the system on which the reasonings have been established; but to another which stands with it in a certain relation; such that in order to render applicable to it the formulas found for this first system, it is necessary to change from + to − the sign which precedes it.

"But from the necessity of placing for example $-y$ in the place of $+y$ it does not follow that the quantity represented by y has become negative; but only that, as has just been proved, it is the difference between two other quantities a, z, of which that which was the greater in the system on which the reasoning was established and the formulas found, has become the least in the system to which it is desired to apply these formulas. For the quantity represented by y being constantly, by hypothesis, the difference between the two quantities, a, z, will be now $a-z$, now $z-a$, according as z is less or greater than a; but in all cases it will be the greater of these two quantities less the lesser, and consequently always positive, and the expression $-y$ will never be anything more than a simple algebraical expression, without signification in itself but having the property that by being substituted in the formulas found, in place of $+y$, it will render them applicable to cases not previously foreseen, or which at least were not included in those on which the reasoning was primarily established."*

The above is precisely the case in the question of equivalents before us. The above quantity, a, may be taken as the common difference in a series of equivalents, and z any term in that series, y the following term. Now the sign of y depends upon the relative greatness of the numbers a and z, but in the words just quoted, "*from the necessity of placing $-y$ in the place of $+y$ it does not follow that the quantity represented by y has become negative.*"

The criticism to which I am now referring has probably been founded upon the very general assumption that a negative quantity is less than nothing. This assumption is so plausible as to

* Carnot, Géometrie de Position, Paris An xi (1803). Dissert. Prél. xix.

have deceived many eminent mathematicians and even Newton himself and Euler. But D'Alembert and Carnot have both pointed out its erroneous nature. D'Alembert states the proportion $1:-1::-1:1$, and observes that if -1 be less than nothing, then it must be less than $+1$, and we should have a greater number standing to a less in the same relation as a less to a greater, which would be an absurdity. Therefore -1 is not a less number than $+1$. Carnot considers this reasoning of D'Alembert unanswerable, and has himself proved the same in an equally ingenious manner. If -3 be less than nothing it must be less than $+2$. But $(-3)^2=9$ and $(+2)^2=4$. Therefore the square of the less number would be greater than the square of the greater, which is absurd.*

Clearly, therefore, it cannot be maintained that negative numbers are less than nothing. Taken in an isolated sense, they are mere mathematical abstractions, but considered in connection with the operations by which they were produced, they are full of significance.

Philadelphia, Sept. 26, 1862.

Art. XXXVI.—*Description of Calamoporæ, found in the gravel deposits near Ann Arbor, Michigan, with some introductory remarks;* by Carl Rominger, M.D.

The alluvial deposits are to me at present the only accessible source for palæontological study, the nearest stratified rocks being 40 miles distant from my location. In passing a gravel-pit, I used to feel a sort of dissatisfaction, because strata of older deposits were hidden from my view, but now, by necessity, I have learned to admire the gravel exposures as a sort of a cabinet, comprising the whole Palæozoic fauna. It is true, that cabinet is in bad order, but fortunately its specimens are so well labelled, that even the effects of a deluge could not destroy the marks, and so, with care, order can be restored. The genus *Calamopora* or *Favosites* is very abundantly represented and its silicified specimens are frequently so finely preserved that, to study their organization, no better material could be wished for.

* Another argument advanced by Carnot and which is equally cogent, is the following which I quote in the original. "Je dis d'abord que la première de ces notions est absurde, et pour la détruire, il suffit de remarquer qu' étant en droit de négliger dans un calcul les quantités nulles, par comparaison à celles qui ne le sont pas, à plus forte raison devrait-on être en droit de négliger celles qui se trouveraient moindres que 0, c'est à dire les quantités negatives; ce qui est certainement faux: donc les quantités negatives ne sont pas moindres que 0." Op. Cit. ix. See also Maseres, "On the use of the Negative Sign." The position assumed by D'Alembert and Carnot appears to be received by modern mathematicians as correct. See remarks of Mr. Galloway in Brande's Dictionary, Art. Negative Numbers.

The following pages will be a description of these remains, and I hope that my observations, although concerning objects which are generally well known, will add something to our knowledge.

Calamopora is defined by Goldfuss as a corallum composed of tubes, which are connected by lateral perforations in the walls, and divided into compartments by transverse diaphragms.

Within these limits he included the genus Chaetetes or Stenopora, supposing its walls to be perforated, but it is now sufficiently ascertained that the coral described by him as *Calamopora fibrosa* has no lateral communication between its tubes.

Milne Edwards, in his Monograph of British Devonian corals, describes and delineates a *Favosites fibrosus*, with lateral pores, and identifies his specimens with Goldfuss's figs. 3*a* and *b*, Tab. 28, but the correctness of this observation is very doubtful; at all events, the specimens from the Eifel, and those which Goldfuss had from Lexington, Kentucky, do not exhibit such perforation.

The distinction made between Chaetetes and Stenopora brings all the American forms, and those from the Eifel, to the latter genus, leaving for Chaetetes only the Russian specimens, which I have never had an opportunity of seeing.

Besides the exclusion of those forms to which the established generic character of Calamopora would not apply, a number of subgenera have been created from the remaining material.

Alveolites comprises Calamoporæ with depressed tubes and similar cell-mouths opening obliquely to the surface, and forming a projecting lip with the exterior half. The connecting pores are proportionally larger and more irregular than in ordinary Calamoporæ, and also the diaphragms are less regular. Its tubes are frequently flexuous, with the side-walls intimately united, and part of the younger tubes appear to be side branches of the older tubes, but simple side-walls and an increase by division of the older tubes are never observed, the walls having always in the centre a distinct line of demarcation.

Alveolites forms generally incrusting masses of laminated structure, but occurs also in the ramose form, which latter is only with difficulty distinguished from a second subgenus, the

Limaria or *Cladopora*, *Striatopora* and *Cœnites*, all of which names are designed for fossils of the same organization.

Limaria is a Calamopora growing in small branches, with very massive tube-walls, and expanded cell-mouths of rounded or transversally elongated shape. Its side pores are large and not numerous, its tubes augment by interpolation, sometimes opening at their lower ends into the side-walls of older tubes, as in Alveolites. Transverse diaphragms perfect, or represented by lateral linguiform projections, but frequently wanting.

Cladopora is said to differ from Limaria by a different shape of the orifices, but it is impossible to draw a line of division between the different forms.

Striatopora is separated on account of its having longitudinal striæ on the inside of its tubes, but this character is essential to Calamopora and to all its sub-genera. In some specimens or species this striation is somewhat obscure, but this does not alter the general rule.

Michelinia includes Calamoporæ with very large tubes and compound vesicular diaphragms. The longitudinal striæ in its tubes are more numerous than in other Calamoporæ and the side pores are remarkably small and irregularly disseminated.

The separate tubes of some corals, connected by lateral processes and with constrictions at various intervals, named by Billings *Haimeophyllum*, under certain circumstances coalesce, and become connected by lateral pores, assuming altogether the form of a Michelinia.

Some other subgenera have been dissevered from Calamopora without any proper justification.

Emmonsia is characterized by tubes in which the ordinary simple diaphragms are in part or wholly replaced by compound and imperfectly developed diaphragms. This character is so little constant that, in the same tubes, a succession of perfectly regular simple diaphragms may be observed, while in previous or subsequent periods of growth only compound and partial diaphragms were deposited.

Astrocerium is not entitled to more credit; it is based upon the presence of rows of spinules on the inner surface of its tubes. Spinules are decorative organs, noticed in a number of other Calamoporæ, which the author allows to bear their old name; these spinules are also not equally well developed in all specimens of the same species and are often obliterated by the effects of petrification.

A character upon which alone a generic distinction is based should not be subject to obliteration by want of development or by the effects of petrification.

Before entering upon a detailed description of species, I have to make some remarks upon the value of the number and disposition of the lateral pores, for specific distinction. It is desirable, that each species of Calamopora should have certain peculiar features, with regard to the size, number and disposition of its lateral pores, which can serve as subordinate characters, for distinction of one kind from the other, but most writers have placed too much importance upon these characters. The tubes of a Calamopora form irregular polygons, which of itself excludes a regularity in the number of pore-rows on a side; but suppose the polygons were regular—the number of rows in a species does not seem to be constant, for the circumference of a tube.

The same want of precision exists with regard to the position of pores on the sides or on the angles.

The organization of the animal does not seem to have been such as to determine, by a sort of mathematical necessity, the position of the pores; on the contrary, it appears that the animal was at perfect liberty to leave *ad libitum* such openings in its walls.

Calamopora favosa Goldfuss, Tab. 26, f. 2.

To determine the identity of fossils described by European writers with those found here, is always connected with some difficulty, but, in this case, the fossil itself is of American origin, and so, by looking over the specimens from the locality indicated (Drummond's Island), *Calamopora favosa* can easily be pointed out. According to Goldfuss's figure its tubes are a little over 3 millimeters wide, and in his rather short description he designates convex diaphragms and two opposite rows of pores on each side as the distinguishing characters of it. It will not appear superfluous, to add to this some more special observations. The tubes, which in a given specimen are all of similar size, have a very variable diameter, between the extremes of 4 millimeters and 1½ millimeter; for example I observed a tube measuring 9 millimeters in one specimen, the tubes of which had an average size of 4 millimeters. The inner side of the tubes is densely covered with spinules, some of which are bifurcated, and which also extend over the upper face of the diaphragms.

The spinules are placed in about 12 longitudinal rows, separated by as many longitudinal sulci, and a transverse order also, corresponding with the lines of growth seen on the outside, can be noticed in the arrangement of the spinules.

Under the magnifier this position of the spinules in rows is not so obvious as with the naked eye, as they appear then more irregularly dispersed. Pores of moderate size are disposed over the sides in 1, 2, or 3 irregular rows, but not as Goldfuss asserts, in pairs; pores placed in pairs are sometimes seen, but this is by no means the rule.

The diaphragms are subject to many variations, some are almost flat, others form a high, rounded or transversely elongated cone, the top of which is often deeply impressed; this impression protrudes on the lower side as a rounded elevation, of which Goldfuss gives a good representation, Tab. 26 fig. 2, 6. Sometimes in the centre of this depression a hole is left open, or it is found closed up subsequently with a solid globular piece.

Marginal depressions in the diaphragms, similar to those figured by Goldfuss in his *Calamopora alveolaris*, are seen in different degrees of development. Sometimes they are hardly to be noticed, at others they become large and give the end cells a starlike appearance. Frequently 12 such depressions encircle the diaphragms, but often less.

Characteristic of this species, are obtusely polygonal concentric rings of growth marking both faces of the diaphragms, and an obscure radial striation, which becomes more distinct on the eroded surfaces.

Usually three or four diaphragms are placed in a space equal to the diameter of a tube, but sometimes only one, for the same distance. The corallum is found in tabular fragments of several inches thickness and nearly parallel tubes, or in biconvex cakes with the lower side surrounded by an epitheca, which however is rarely well preserved.

Calamopora Niagarensis Hall, and part of *favosa* Hall; *Calamopora Gothlandica* auctorum: *Dania Huronica?*

I adopt the name *Niagarensis*, in preference to *Gothlandica*, because the first name is less abused, while the latter has been applied to so many different species that nobody knows which is the genuine. Even Goldfuss himself confounded different corals under that name. The Eifel specimens of *Calamopora Gothlandica* are at all events totally different from the Niagara specimens.

Under the name *Niagarensis*, I comprise forms which are found associated, and do not differ from each other, except in the size of their tubes, which varies from two to four millimeters in different specimens. The inside of the sharp-edged polygonal tubes is covered with small delicate spinules; some specimens appear to be entirely smooth, but, even in these, usually some tubes can be found in which the spinules are preserved.

Pores are small, not crowded, and with no elevated border, from 1 to 4 rows may be counted on a side, the number of rows on the circumference of a tube does not seem to exceed 15, more frequently a smaller number occurs. Diaphragms flat, sometimes slightly concave, or flexuous, in consequence of the development of a few marginal depressions; or stellate, if these depressions have become more numerous and more regular. Most frequently from 5 to 12 such depressions are observed, but in some tubes I have noticed more than 12.

All these variations in the diaphragms can be observed at once in a single specimen, but most frequently the diaphragms are perfectly flat, horizontal, or occasionally oblique, their upper face is also decorated with spinules, which however are seldom preserved.

Distance of diaphragms variable from the thickness of paper to more than the diameter of a tube. This variation occurs sometimes in the prolongation of one and the same tube, or cluster of tubes.

A number of specimens, and those with closely approximated diaphragms in particular, have a laminated structure, and the side pores are disguised by the densely crowded diaphragms, or by incrustation. I strongly suspect that by misapprehension of such specimens the genus Dania has been called into existence, and will finally have to be erased from the list of names.

The corallum is found in tabular undulated fragments, with parallel tubes; or in placentiform expansions, with flattened or conical base, on which sometimes remains of an epitheca are preserved. *Calamopora Gothlandica* from the Eifel differs from it, by the inequality and more rounded nature of its tubes, by its tuberose or piriform mode of growth, by much coarser and more numerous spinules on the side-walls, by much larger and more numerous lateral pores, which are surrounded by a shallow excavation, from the upper end of which a large spine generally protrudes.

Calamopora venusta Hall.—*Astrocerium venustum* Hall, is a very near relative of the two former species. Its tubes are about one millimeter wide, sometimes less.

Twelve longitudinal rows of spinules are planted on the inner circumference of the tubes, which often grow so long as to reach the centre. The upper face of the diaphragms is also spinulous. The diaphragms are flat, but often also of warped aspect, from the presence of lateral depressions. Pores are disposed along the sides in one or two rows.

In some specimens the tubes are more than one millimeter wide, and the spinules not so largely developed, but otherwise they do not seem to differ much. It occurs in our gravel banks usually in fragments of larger masses, or in placentiform laminate expansions with an epitheca on the lower side. The rock enclosing the three preceding Calamoporæ is so similar to the rocks of Drummond's Island that specimens laid side by side cannot be distinguished from each other.

The following species of Calamopora occur in a siliceo-calcareous rock, which, judging from the character of its fossils, is identical with the Corniferous limestone of New York and Canada.

Calamopora hemispherica Yandell and Shumard; *Favosites alveolaris* Hall, Geol. Report New York, 4 Distr.; *Emmonsia hemispherica* Milne Edwards and Haime; *Favosites hemispherica* Billings, Canad. Journ. 1859.

This coral is found in a number of different varieties, which are so intimately connected by intermediate forms that it would be unnatural to undertake a division into several species. Milne Edwards enumerates three species, which are distinguished by the size of the tubes, by more or less regularity in the diaphragms, and by the number of pore-rows on a side, all of which characters are very variable, even in single specimens, and consequently cannot be relied on. Specimens with tubes nearly three millimetres wide, and others in all gradations down to tubes of one millimetre, or even less, are equally common.

A certain size of tubes is always predominant in specimens, but smaller and larger ones are found intermingled. Exteriorly the tubes are smooth, or marked with transverse lines of growth, polygonal; interiorly, frequently rounded, with from 12 to 14 linear longitudinal sulci, including in this number the lines formed by the angles of the polygons. Most characteristic of this species are horizontal, or variously oblique or flexuous, linguiform lamellæ, which project from the side-walls of the tubes in various degrees of development and of multitude.

These lamellæ are perfect analogues of the spinules of the above described species from the Niagara group, and must not be confounded with the ordinary diaphragms, although they can take their place and function.

In some specimens regular diaphragms divide the tubes, and the intervals between them are found either studded with shorter lamellæ, or interrupted by partial compound diaphragms, formed by the enlarged and coalesced lamellæ. In other specimens no regular simple diaphragms can be found, and the irregularly coalesced lamellæ replace them altogether; but even in those specimens in which, at certain periods of growth, no regular diaphragm can be noticed, successively, or abruptly, the tubes may alter their appearance, and, for a while, only regular simple diaphragms may be seen, with the intervals between them entirely smooth. This circumstance proves satisfactorily that the different degrees of development of these organs, far from being of generical importance, are not even constant in the prolongation of one and the same tube.

In some specimens the lateral lamellæ form twelve tolerably regular longitudinal rows, which are separated by the longitudinal furrows, but in other specimens smaller and larger lamellæ, horizontal, oblique, or flexuous, are dispersed in perfect disorder, forming by their coalescence a coarse cellular tissue, rather than a series of diaphragms. The diaphragms formed of lamellæ more equal in size and position, have a stellate surface, from the cicatrices indicating the outlines of the component lamellæ. Milne Edwards, probably having in view this kind of diaphragms, speaks of "12 vertical lamellæ reaching to the centre of the tabulæ," but the vertical lamellæ and the tabulæ are in this case one and the same thing.

The pores form from 8 to 12 rows on the circumference of a tube, are large and numerous; surrounded by a prominent rim, or not. They seem to be more numerous in the tubes with complicated diaphragms, than in those which have them more simple.

By disease, parts of some specimens of this coral have become so transformed that they would not be suspected to be Calamoporæ, if they were not connected with tubes of regular form. Casts of such specimens are represented by a network, composed of geniculate, nodose, vertical columns, which are connected by numerous horizontal side branches, equally thick with the columns. The walls of the tube and its lamellæ are thickened enormously at the expense of the openings, while at the same time, the side-pores enlarged, and assumed the form of connecting tubes. A similar disease is noticed in some ramose specimens of Calamopora, from the Eifel, which appear like solid branches, perfectly, penetrated by tortuous worm holes.

The external form of this coral is indicated by its name. Rarely remainders of an epitheca can be noticed, which seemed to be restricted to a small root portion.

Calamopora epidermata; Calamopora Gothlandica Billings, Canad. Journal, 1859, p. 104.

Billings confounds this coral with specimens of the Niagara group as well as with Eifel specimens, but with neither of them has it much similarity. By having lamellose projections on the side-walls instead of spinules, it differs from both, and shows its close affinity to *Calamopora hemispherica*, from which it differs, by a different mode of growth, by larger tubes, by regular simple diaphragms, and by smaller less numerous side-pores; but because *C. hemispherica* sometimes has also its diaphragms more regular, and does not differ very much in the size of its tubes, it becomes sometimes very difficult to determine, in fragments, to which species they belong. It grows in placentiform, lobate expansions, with a conical basal portion; from the surface of these expansions, new expansions sprout up in terrace-form. The whole underside of the mother expansion, as well as of the terraces, is covered with a concentrically wrinkled epitheca. The tubes which have in *C. hemispherica* an inclination to form an arch directed outwards, are in this species more bent upwards, which is the cause of its having a flattened placentiform surface.

It is already mentioned, that lamelliform horizontal projections entirely similar to those of *C. hemispherica* are placed on the inside of the tube-walls, but these remain in the form of linguiform squamæ, and do not often help to form the diaphragms, which are perfectly regular, flat, or warped by the development of some lateral depressions. These depressions are in this species never so numerous and so regular as to give the end cells a star-like aspect.

Distance of diaphragms not large, usually three or four in the space of a tube-diameter, which varies from two to three millimeters, in the same specimen. Twelve longitudinal linear sulci are well marked.

The pores are moderate in size and in number, surrounded by a prominent rim and forming one or two irregular rows on each side.

Calamopora Winchelli, n. s.

Tubes rounded, or obtusely polygonal, from three to four millimeters wide, interspersed with many smaller ones. Walls marked with 12 longitudinal sulci but otherwise smooth. Diaphragms distant, simple, flat, promiscuously horizontal, or in all degrees of obliquity; frequently they become flexuous, by lateral depressions, or one of these depressions is so strongly developed as to occupy the whole diaphragm, and to transform it into a funnel.

Pores are large, surrounded by a rim, moderately numerous, forming from 8 to 12 rows on the circumference of a tube.

The corallum occurs in irregular subglobose masses. A piece of epithecal crust preserved in a specimen has, besides the concentric lines of growth, also fine longitudinal striæ. It is found enclosed in the same rocks with the formerly described species; one specimen I took from a sandstone boulder, containing a number of fossils characteristic of the Oriskany sandstone.

Calamopora Canadensis; Fistulipora Canadensis Billings, Canad. Journ. 1859, p. 98, fig. 1.

It grows in large undulated expansions, of a thickness variable from a few lines to more than an inch. From the surface of these similar expansions sprout up, forming gradually a cavernous superstructure, the floors of which, on the under side, are all covered with an epitheca, so thin that the outlines of the tubes show through it. Its tubes are of two sizes, and so disposed as to give to the surface the appearance of a Heliolites. The larger ones are perfectly round, and measure about one millimeter, the smaller ones are angular, and are only half a millimeter wide.

Twelve distinct longitudinal ridges can be observed on the casts of the larger tubes, and also on the smaller tubes longitudinal striæ can be noticed.

Both kinds of tubes are divided by regular perfect diaphragms. In the larger tubes, the intervals between the diaphragms exhibit a small number of linguiform lamellæ, similar to those of *Calamopora hemispherica*, or *C. epidermata.*

Pores surrounded by an elevated border, quite numerous on the larger tube as well as on the smaller ones.

Calamopora heliolitiformis, n. s.

Differs from the former species by having larger tubes, and by its growth in subglobose masses and not in flat expansions.

The larger round tubes measure not quite two millimeters, the smaller angular tubes one millimeter. Diaphragms of the smaller tubes simple, straight, and somewhat distant, in the larger tubes simple and compound or imperfect diaphragms are intermingled as in *Calamopora hemispherica.*

Pores are large and numerous, surrounded by a prominent rim, placed in a single row on the sides of the smaller tubes; the number of rows on the circumference of the larger tubes I could not accurately ascertain. Also longitudinal sulci are noticed, but in the specimens they are not plain enough to be counted.

Calamopora basaltica, Goldfuss Tab. 26, fig. 4.

Occurs in tuberose or pyriform, glandular masses, with more or less unequal polygonal tubes, from one to two millimeters wide, ascending in a gentle curve, from the interior to the outside.

Diaphragms flat, simple, or more frequently compound, distant about one millimeter. In parts of the surface, all the tube-mouths are found closed up by opercula of a more substantial and more regular construction than the ordinary diaphragms. The latter are compounded of from five to eight linguiform lamellæ, unequal in size and in level, so as to form by coalescence an irregular angular surface; the opercula are formed by 12 such lamellæ, equal in size and in level, the sutures of which give them a regular stelliform appearance. The centre of the operculum is formed by a circular piece of concentrical structure, and not by the coalesced acumina of the lamellæ composing the external ring.

A similarly constructed operculum is described in *Callopora elegantula* by Hall (Palæontology of New York, vol. ii, p. 144). The opercula, as well as the ordinary diaphragms, can sometimes be observed in the young state, in which the constituent lamellæ have not yet grown so far as to become contiguous, therefore in the centre a corresponding stellate opening is seen.

The compound diaphragms of this species are always in regular superposition, and do not exhibit the cellulose confused condition which was described in *Calamopora hemispherica.* From the side view they appear to be simple, and only rarely some isolated lamellæ are found protruding in the intervals between them.

Pores form one, sometimes two, rows on each side.

The adjoining tube-walls are separated at the surface by very plain lines of demarcation which are sharply polygonal, while the openings of the tubes often have a more rounded aspect.

Calamopora turbinata Billings, Canad. Journ., 1859, p. 109; Ib. 1860, May number.

This peculiar Calamopora is a very near relative to *C. basaltica*, and differs from it only in external form, which is either turbinate, like a turbinate Cyathophyllum, or it forms large lenticular masses, with coarse rounded folds on the lower side which is generally exposed, while the upper side is almost invariably adhering to the enclosing rock; or in other cases, the internal portions of the coral are decomposed, and only the external ends of the tubes, which are strengthened by their massive opercula, are left in the form of excavated horns, or more expanded funnels or dishes. Billings has described the corals so well that any farther remark is superfluous. He calls the appearance of an operculum an epitheca, which word should be restricted to a different sort of an envelope.

It is rarely found silicified, in association with the other Corniferous limestone fossils; it is very common in calcareous fragments containing immense numbers of broken Brachiopods, Crinoidal stems, and Bryozoa, belonging to the lower strata of the Helderberg group.

Calamopora polymorpha belongs to more destructible *calcareo-argillaceous* strata, and is very poorly preserved in our gravel. The ramose forms known as *C. cervicornis*, *C. reticulata*, and *C. dubia*, with a number of allied forms, are found finely preserved, but I reserve their description for some future communication, which will also embrace the numerous varieties of Limaria, and the ramose forms of Alveolites.

Michelinia convexa D'Orbigny; Billings, Canad. Journ., 1859, p. 112.

It is not unfrequently found, but rarely well preserved.

Omitting a general description, I have only to mention a remark of Mr. Billings, that Michelinia differs from Favosites by having the vertical lamellæ represented by vertical striæ, while in Favosites series of minute spinules form the equivalent. But *Michelinia convexa* and also *M. favosoidea* have the inside covered with just as many rows of spinules as they have longitudinal striæ, because every interval between two striæ bears a row of spinules. On the other hand the striæ are also well enough developed in Calamopora, only less numerous than in Michelinia.

Michelinia intermittens Billings; Canad. Journ., 1859.

A coral which corresponds perfectly with the description given by Mr. Billings is not rare here.

Its tubes are frequently contiguous and connected by lateral pores, which are placed in the intervals between the constrictions; diaphragms vesicular, longitudinal striæ indistinct, and spinules irregularly dispered over the interior of the side-walls.

In parts of the same specimens the tubes are free, only connected by lateral processes, and exhibit all the characters described by Billings in *Haimeophyllum ordinatum* (Canad. Journ., 1859, p. 140). This species consequently has to receive the name Haimeophyllum, the affinity of which to Michelinia is already mentioned in Mr. Billings's essay.

ART. XXXVII.—*On a remarkable form of Rotation in the pith cells of Saururus cernuus;* by GEORGE C. SCHAEFFER, M.D.

WHILE examining the intimate structure of various plants, I discovered, in the year 1854, a peculiar motion in some of the pith cells of *Saururus cernuus*, which was so different from any thing before described that it seemed to be quite abnormal. Continued observation for eight years has shown however that, for this plant at least, the phenomenon is constant, while an equally long continued examination of the writers on such subjects, has proved that no record of this appearance has ever been made. As a mere microscopical curiosity the fact might be deemed worthy of notice, but the remarkable similarity to a motion which has been considered as invariably connected with a distinct and peculiar vegetable function, seems to render its record needful for the true advancement of vegetable physiology.

The *Saururus cernuus*, like many other aquatic or marsh plants, has a pith, the cells of which are not in complete juxtaposition, but separated in part by vertical air passages which are as regularly built around by the cells as a chimney is by its bricks, with this difference, however, that the cells are arranged directly one above another, and do not "break joint" as the bricks would in any properly constructed chimney—no fault in Nature's workmanship, we should remark, since the pith is a mere filling in, surrounded by a much denser and more solidly built structure.

The cells in which the above mentioned motion occurs are not those from which the party walls of each air passage diverge, but those forming the middle of the wall between any two contiguous channels; they seem to be smaller and *younger* cells than the others.

In all ordinary cases of *cyclosis* the motion is along the walls of the cell, coming and going in paths which are, for the time at least, permanent. But in the *Saururus* the granules lie in the centre of the cells above described and their motion is of a quite different character. To those familiar with microscopic observations, we may best describe this motion as perfectly identical with that seen in the, so-called, vesicles, in the ends of *Closte-*

rium, which has been aptly styled "swarming" by the English and Germans. The granules are quite minute, rounded in form and rather unequal in size. Sometimes a cell is seen in which all motion has ceased, in such cases the granules are always closely crowded together in the centre of the cell.

The time during which this motion continues is quite remarkable. Specimens of the plant kept for several days in water never fail to show it, while the proper pith cells of all parts of the plant, even of the blanched portions of the stem growing beneath the mud, seem equally active. Indeed no form of *cyclosis*, of which this is undoubtedly one, is so easily demonstrated.

The nature of the granules however is not so readily determined, for they do not show the starch reaction with tincture of iodine, neither are they colored as proteine compounds, (and such I had at first supposed them to be,) would be under this reagent. There is however a remarkable difficulty, common also to many others, in applying chemical tests to sections of this plant, and this consists in the rapid discoloration of the specimens, owing to the presence of tannic acid which acts upon the iron of the cutting instrument. It is quite certain however that the granules are neither starch nor proteine, whether they are, the so-called, aleurone, I am unable to say.

To those familiar with the microscopic examination of freshwater algæ, this "swarming" apart from the best known case of the *Closterium*, must be quite familiar—but such motions have always been considered as in some way connected with sexual reproduction. In the case in question however nothing of the kind can possibly occur—for the *Saururus* is, beyond a doubt, not only a phænogamous, but even a dicotyledonous plant, closely allied to the Pepper family. The cells in which this motion is seen are evidently smaller and younger than those in their immediate vicinity. Sometimes indeed two vertical rows of small cells show the same motion. The phenomenon in question would therefore merely indicate *active cell multiplication* and not *plant reproduction*, to which similar appearances have always been referred. With a somewhat extensive experience I am able to say that nothing of the kind has before been observed in phænogamous plants; yet it must be admitted that one single instance among them is sufficient to invalidate the inferences formerly drawn from algæ, as to the true meaning of this peculiar kind of motion.

I am more earnestly disposed to insist upon this, apparently, exceptional case because it confirms views long held and taught by myself as to the purely physico-chemical interpretation of most of the phenomena of vegetable life.

Washington, D. C., September, 1862.

ART. XXXVIII.—*On the occurrence of Triphyline at Norwich, in Massachusetts;* by GEORGE J. BRUSH.

IT is well known that a crystallized phosphate of manganese, iron, and lithia was found by Hitchcock and Hartwell, associated with the spodumene from Norwich, Mass., and that the crystalline form, and chemical composition of this substance have been investigated by several mineralogists and chemists. Prof. Dana and Mr. Craw* have shown this phosphate to be near triphyline, although, as Mr. Craw states, "the results of his investigation tend to prove a wide difference from that species rather than an identity with it." Prof. Shepard† refers the mineral to triplite, and calls attention to the circumstance that Mr. Craw's analysis connects the mineral with Damour's *alluaudite* rather than with *triphyline.* Dr. Mallett's‡ analysis does not differ essentially from that by Mr. Craw, and all these writers agree in considering the substance as an altered mineral.

Quite recently I have received from Prof. E. Hitchcock, Jr., some specimens which afford a solution of the question as to the character of the original mineral. Externally the specimens have an iron-black color; on the fracture, however, this iron-black substance is shown to be a mere crust, having but an imperfect cleavage, and passing gradually into a distinctly cleavable green mineral, which occupies the centre of the crystal. On examination, this central mass proves to be identical with *triphyline,* as will be seen by the following physical and pyrognostic characters: cleavage distinct in two directions, one quite perfect; color grayish-green, in thin fragments translucent; streak white; lustre vitreous inclining to greasy. H. = 5. Sp. Gr. = 3·534. Heated in the closed tube decrepitates, blackens, and gives a faint trace of moisture. On charcoal fuses readily to a black magnetic globule. In the forceps fuses, blackens, and in the outer flame gives reactions for lithia and phosphoric acid; in the reducing flame becomes magnetic. Fused in a glass tube with sodium yields a phosphid, which on treatment with water gives copious fumes of phosphuretted hydrogen. Dissolves in borax, soda, and salt of phosphorus, reacting for iron and manganese.

These characters are identical with those of the triphyline from Rabenstein in Bavaria, and the source of the altered phosphates of manganese and iron found at Norwich is thus shown to be *triphyline.* This fact is also of further interest, as being the first time that triphyline has been identified as occurring in this country.

Sheffield Laboratory, Yale College, Oct. 17th, 1862.

* This Journal, [2], xi, 99. † Rep. Am. Assoc. Ad. Sci., 6th meeting, p. 234.
‡ This Journal, [2], xviii, 33.

SCIENTIFIC INTELLIGENCE.

I. PHYSICS AND CHEMISTRY.

PHYSICS.—

1. *Contributions to the Spectral Analysis.*—In examining with the spectroscope a substance containing baryta, A. Mitscherlich observed two bright green bands which appeared to indicate the presence of a new metal. On further investigation it was found that the same lines were obtained, sometimes alone, sometimes together with barium lines, when a solution of chlorid of barium containing sal-ammoniac is employed. By means of a simple apparatus, consisting essentially of a glass tube closed at its lower end by a bundle of fine platinum wires and filled with the liquid to be examined, the author obtained colored flames of great intensity and long duration, the wires serving by capillary action to feed the flame of the burner. A mixture of 1 part of a concentrated solution of chlorid of barium with 20 parts of a solution of sal-ammoniac and 20 parts of chlorhydric acid containing about 20 parts of real acid gives the two green lines above mentioned. By employing solutions of the chlorids of calcium or strontium mixed with sal-ammoniac, new spectra are obtained which differ greatly from the ordinary spectra, but which are seldom quite free from them. Even to the eye alone the new flames differ in color from those obtained by employing the metallic salts without the addition of sal-ammoniac. From this it follows that the spectrum of the metals of the alkaline earths, is different from that of their chlorids. That the mere presence of sal-ammoniac without chemical action is not the cause of this difference, is shown by the fact that the ordinary or metallic spectra are not changed by passing the light through a flame containing sal-ammoniac. The spectra of protochlorid and subchlorid of copper were found to be different though usually more or less mixed in consequence of the reduction of the chlorid to subchlorid by heat. By introducing several substances into the same flame particular lines often vanish; thus the blue strontium line disappears when chlorid of copper, sal-ammoniac and chlorid of strontium are mixed. The chlorids of potassium and sodium give no spectra as such. The potassium spectrum vanishes when the chlorid is mixed with sal-ammoniac and chlorhydric acid. The sodium reaction is too delicate for this experiment, but the author found that light transmitted through the vapor of the ignited chlorid gave no sodium line.

From the above it follows that the metals do not give a spectrum in all their compounds, and that they do not give the same spectrum in different compounds, but that the character of the spectrum depends upon whether it is produced by the metal or by one of its compounds of the first order. It further appears that every compound of the first order, if it have a spectrum other than that produced by decomposition, must have a spectrum of its own. Metallic compounds are so easily reduced by the flame that we usually obtain only the spectra of the metals themselves. Light passed through ignited soda vapors, or vapors of the carbonate of soda, does not give the sodium line D, but the vapor of metallic sodium at a low red heat exhibits this line distinctly. From this it follows that in those flames which exhibit the sodium line, metallic sodium, as such, produces the line in question, and since sodium has almost the greatest affinity for oxygen it follows that all spectra which are produced by oxyds are metallic spectra. The author further suggests that these experiments enable us to determine the affinities of the elements at the temperature of the sun's atmosphere by the spectral analysis. If, for instance, we observe the spectrum of a particular metallic chlorid in the sun's light, we should have to conclude that at the temperature of the sun's atmosphere the metal in question has a greater affinity for chlorine than potassium or sodium, since these exist as metals in the sun's atmosphere. Moreover we may hereafter, conversely, determine the temperature of the sun's atmosphere from the nature of the chemical compounds which exist in it, provided that we succeed in obtaining an approximately high temperature.

From the fact that free potassium and sodium exist in the sun's atmosphere, it follows that no free electro-negative body like oxygen, sulphur, &c., can be present, and not even enough to combine with all the sodium. Consequently all metals which are reduced from their compounds by sodium must exist in the sun's atmosphere in the free state.* The absence in the solar spectrum of the lines of a particular metal does not prove the absence of the metal itself, since it may exist in combination with some element, the compound itself exhibiting no spectrum. The many new lines recently discovered in the spectrum and to which no elements are known to correspond, may prove to be the lines of compounds of the first order of metals already known.—*Pogg. Ann.* cxvi, 499.

2. *Researches on the Solar Spectrum.*—After much delay we have received the long expected memoir of Kirchhoff on the spectrum, a work which has already passed to a second edition, and which can hardly fail to become the standard authority on the subject. The memoir in question is taken from the Transactions of the Royal Society of Berlin, and is accompanied by two plates of the spectrum and one of the apparatus employed. The plates are unfortunately not colored, and are lithographed instead of engraved. They represent only the portion of the spectrum which extends from the line D to the line G, the author being prevented by the condition of his eyes from revising other portions, the survey of

* This conclusion does not appear to us justified upon chemical considerations. For it may be that the oxyds, sulphids, chlorids, &c., of sodium and potassium are decomposed into their elements at the temperature of the sun's atmosphere, and consequently sodium, potassium, oxygen, sulphur, chlorine, &c., may be coëxistent in the free state in the sun's atmosphere and there may be far more than enough oxygen, &c,, to combine with all the potassium and sodium. It would be unsafe to argue that because oxygen is the most abundant terrestrial, it must also necessarily be the most abundant solar element, yet such is possibly the case. Moreover it is not necessarily true that all metals which are reduced from their compounds by sodium must exist in the sun's atmosphere in a free state, because the masses or absolute quantities as well as the temperatures must be taken into consideration in judging of the affinities actually controlling combination.

Mitscherlich's experiments are certainly of great interest, and in fact form the second great step in our knowledge of the constitution of the sun's atmosphere. There are few branches of science which promise more magnificent results than the spectral analysis, but few which will require more cautious reasoning or more guarded and careful experiments. W. G.

which was complete. The solar lines are, for convenience, represented upon the charts together with the chemical lines, as we may term them, the author giving all the most characteristic lines presented by iron, cobalt, nickel, zinc, cadmium, gold, silver, arsenic, antimony, tin, bismuth, lead, copper, potassium, sodium, barium, strontium, calcium, magnesium, aluminum, cæsium and rubidium, at least those which lie between the lines D and G. While the charts are very admirable and reliable, they still leave much to be desired in a chemical point of view and for the purposes of analysis, because a separate chart is needed for the spectrum of each element to give a clear view of its optical characteristics. The author does not state in what manner the elements were obtained in the state of absolute chemical purity required by the peculiar nature of the problems to be solved, nor have we the guarantee of Bunsen's name and authority upon this most important point. Kirchhoff's apparatus consisted essentially of four flint glass prisms, three of which had refracting angles of 45°, the fourth an angle of 60°; the edges of the prisms could be made vertical by means of screws; a condensing and an observing telescope completed the instrument. The distances of the lines were measured by means of a micrometer screw by which the observing telescope was moved. The map of the spectrum is accompanied by a millimeter scale with an arbitrary initial point; this renders the identification of the lines easy. The map represents the spectrum as seen when the sun's altitude is great, and the author has not inserted the lines due to atmospheric absorption, though he frequently observed their great beauty especially in the neighborhood of D. For the production of metallic spectra the author employed almost exclusively the electric spark, in consequence of the great intensity of the light: a Ruhmkorff's coil was found advantageous, in some cases the lines have a measurable breadth and such cases are noted by a bracket in the drawing. The bright lines due to the passage of the spark through the air were not very perceptible; the author has represented of these only a group in the yellow and one in the green, but the brightest of the metallic lines are represented. In some cases the author observed coincidences of position in the lines of different metals: he suggests that these may be only apparent and that separation might be effected by a greater number of prisms, but it seems to us equally probable that the metals examined may not have been absolutely pure. The position of the maxima of light in the spectrum of any metal does not depend on the temperature, the presence of other vapors, or upon any condition other than the chemical nature of the vapor itself. On the other hand the relative intensity of the different maxima depends not only on the temperature but upon the changes in the mass of the vapor, so that the appearance of the spectrum at different temperatures may be very different. The inversion of the bright lines in metallic spectra produced by passing an intense light through the flame containing the metallic vapor is now a familiar fact. The author refers this fact to a general physical principle, namely, that for every species of ray the ratio between the power of radiation and the power of absorption is equal for all bodies at the same temperature. The mathematical demonstration of this principle forms an appendix to the second edition of the memoir. From this principle it immediately follows that an ignited gas, in whose spectrum certain colors are wanting which are present in the spectrum of another body at the same temperature, is perfectly transparent for rays of these colors, and that it exerts upon rays of any color present in its spectrum an absorption which is powerful in its proportion to the brightness of this color in its own spectrum. It also follows that when the source of light which produces a continuous spectrum by which the spectrum of an ignited gas is inverted, is an ignited body, its temperature must be higher than that of the ignited gas.

The application of these principles to the determination of the chemical constitution of the sun's atmosphere is well known. The author calculates the probability that the coincidence of 60 iron lines with 60 dark lines of the spectrum is simply accidental to be less than $(\frac{1}{2})^{60}$, that is, $\frac{1}{1.000.000.000.000.000.000}$. He considers the existence of iron, chromium, nickel, calcium, magnesium, and sodium in the sun's atmosphere to be clearly proved. Barium, copper and zinc appear to be present in small quantity. Gold, silver, mercury, aluminum, cadmium, tin, lead, antimony, arsenic, strontium, lithium, and silicon could not be detected. Kirchhoff considers that the most probable assumption which we can make as to the physical constitution of the sun is that the body consists of an intensely ignited solid or fluid core surrounded by an atmosphere of somewhat lower temperature, a theory which is perfectly consistent with the nebular theory of Laplace. He elucidates and defends this theory at length, maintaining that it is consistent with astronomical observations. For a full statement of the author's views on this subject however we must refer to the original memoir as the argument does not well admit of condensation. W. G.

3. *Some observations of the Solar Spectrum.*—Weiss has availed himself of favorable opportunities presented by a voyage to the Ionian Isles to examine the thickening of the dark lines in the solar spectrum produced by atmospheric absorption. The thickening of the lines in the red and yellow portions of the spectrum, as well as an increase in their number, was distinctly and repeatedly observed. The author believes that his observations establish the fact that the thickening of the dark lines proceeds towards the violet end of the spectrum in each instance, precisely as in the case of hyponitric acid and chlorophyll. The instrument employed was a Soleil's spectroscope and the observations were made at sunrise and sunset, the clearness of the atmosphere being extremely favorable.—*Pogg. Ann.* cxvii, 191. W. G.

[*Note.*—We may here remark that the spectroscope promises to give important information with respect to several luminous phenomena of great interest. We mention as illustrations the aurora borealis, the zodiacal light, the colors of sunset clouds, and the light of comets. A comparison of the light of the aurora borealis, with the spectra produced by electric discharges in Geissler's tubes filled with rarefied air, oxygen, and nitrogen would be of great interest as confirming the electric origin of this phenomenon. If the zodiacal light be due to a ring of nebulous matter around the sun or around the earth it should exhibit lines corresponding to the vapors which it contains. A careful study of the colors of clouds at sunrise and sunset may explain the appearance of particular lines in the spectrum itself. Sufficient light may in all these cases be obtained by the use of a condensing lens. The spectra of several fixed stars have recently been studied by a zealous amateur astronomer in the city of New York, provided with excellent instruments, and we hope soon to lay his results before the public.] W. G.

4. *On the Blue Lithium line.*—FRANKLAND, in a letter to TYNDALL, describes a magnificent blue line in the spectrum of lithium. This line does not appear when an ordinary Bunsen's burner is employed but is seen, although faintly, when a hydrogen flame is used, and becomes very brilliant when the lithium salt is heated in the oxyhydrogen flame. From this it appears that a very high temperature is necessary to bring out the blue line distinctly. Kirchhoff has already directed attention to the fact, that the appearance of the spectrum may be greatly altered by an increase of temperature, the characteristic spectrum still remaining unchanged.—*Journ. für prakt. Chemie*, lxxxvi, p. 255.

5. *On the projection of the colored rays of Metallic Spectra.*—DEBRAY has given some interesting notes on the projection of spectra by employing the oxyhydrogen blowpipe instead of the common Bunsen's burner. The author first describes a convenient form of the lime-light suitable for the projection of optical phenomena generally and then gives some details of apparatus and processes for the preparation of hydrogen and oxygen gases. When the oxyhydrogen flame is employed to heat metallic salts in projecting spectra, it is found that, as already remarked by Kirchhoff, Frankland and Tyndall, new brilliant rays often make their appearance, due to the influence of the high temperature employed. In this manner potash salts give four new triple rays of great distinctness, the first near the line D, the others from the green to the blue. The red potassium line is also distinctly doubled. Copper and lead are remarkable for the number of their rays and for the intensity and extent of the violet portions of their spectra. The author found the flame-spectre essentially identical with those obtained by means of the electric spark. This result had also been obtained by Bunsen and Kirchhoff.—*Ann. de Chemie et de Physique*, lxv, 331. W. G.

CHEMISTRY.—

6. *Lithium and Strontium in a Meteorite.*—ENGELBACH has detected lithium and strontium in a meteoric stone from the Cape. The stone was digested with fuming chlorhydric acid; the liquid evaporated gave a strong sodium reaction, showed the lines Kα and Liα faintly, a complete Calcium spectrum and, though faintly, the strontium lines α, β and γ.—*Pogg. Ann.* cxvi, 512. W. G.

[*Note.*—As strong chlorhydric acid acts directly upon glass, is it not possible that the alkalies in the solution may have been derived from the glass bottle in which the acid was kept? The excessive delicacy of the spectral analysis requires the most careful examination of the purity of the reagents employed.—W. G.]

7. *On the presence of Rubidium in certain plants.*—GRANDEAU has discovered rubidium in the ashes of the beet, in tobacco, coffee, tea, and raw tartar. The author believes that this metal is one of the more widely distributed elements and that its presence is not necessarily associated with that of lithium, as might be supposed from the analyses of minerals and mineral waters.—*Compt. Rendus*, liv, 1057. W. G.

8. *On a presumed conversion of Phenylic into Rosalic acid, and some applications of this acid and compounds in the production of various colors on Wool and Silk;* by BALTHAN BINDER. (Communicated by the author).—Experimenting with some of the bases contained in coal-tar, and more especially in an endeavor to procure decomposition of phenylic acid into benzole, I obtained the following results, which I deem sufficiently interesting and new to communicate. To decompose the phenylic acid as above, I proposed to bring sulpho-phenylic acid into contact with hydrogen in its nascent state, as follows: to the acid placed in a retort, to which a receiver was connected with an intervening refrigerator, was added a quantity of granulated zinc; reaction was engendered by gradually raising the temperature in the retort to 30°, 60°, 90°, 120°, 150° Centigrade, until reaction ceased, after ten hours; reaction was active with disengagement of sulphurous acid, hydrogen and sulphureted hydrogen. Compared to the quantity of sulpho-phenylic acid employed, but a small quantity of a colorless oily liquid, with some water, condensed in the receiver, and this, in lieu of benzole, had all the properties of phenylic acid. In the retort remained a black resinous-looking substance, which while warm was emptied into a digester, a solution of sulphuret of barium in excess added and the temperature raised to boiling. The solution, at first dirty-looking, assumed a brilliant rose color, a disengagement of sulphureted hydrogen taking place with a precipitate of sulphate of baryta and sulphuret of zinc and an insoluble organic substance. The solution after filtering and slight oversaturation with acetic or muriatic acid precipitates a flocculent orange-colored substance, which when heated cakes to a resinous looking body, with slight metallic reflection. This was further purified by re-dissolving with hydrate of baryta (other alkalies will of course serve the same purpose) in water and re-precipitated. It dissolves readily in alcohol or wood-naphtha, slightly in cold, more in boiling water; when purified and dried, is of a bright dark amorphous look, with slight greenish metallic lustre; its powder is of a dark red shade, in thin layers of an orange red when viewed with transmitted light; its watery solutions tinge wool and silk of a bright orange color, and the shades thus obtained being saturated with various alkalies, will produce orange-red, purplish-red to crimson shades, of very handsome grades. While this salt directly applied will not dye fast colors, to judge from the chemical properties of this substance, I believe it to be identical with rosalic acid, or at least a modification of it.

June 29, 1862.

9. *On the transformation of Phenate into Rosalate of Lime;* by B. BINDER. (Communicated by the author).—Referring to my former article, on the presumed conversion of phenylic into rosalic acid, I have since observed that phenate of lime placed over concentrated (not fuming) sulphuric acid in a confined space (under a bell glass) for the space of five or six months, will be largely coverted into rosalate of lime, while in free air no trace of such change is observed. The salts thus formed are readily separated by diluting with warm water, and saturating the lime with hydrochloric acid, when the phenylic acid will rise to the surface, while the rosalic acid precipitates. The first can be decanted from the muriate of lime, the remainder filtered, the latter will remain on the

filter, and can then be purified by proper treatment, when it will have all the chemical properties mentioned in my former article of what I presumed to be rosalic acid obtained from the treatment of phenylic acid.

Tacony Chem. Laboratory, (Bridesburg,) Philadelphia, Aug. 7, 1862.

10. *Thallium.*—CROOKES has sent us an early copy of his "*Preliminary researches on Thallium*" from the Proceedings of the Royal Society. Crookes' discovery of this new metallic element was published March, 1861, and therefore completely antedates the paper of Lamy, an abstract of which is given on page 275–6 of this volume. The name *Thallium*, is derived from the Greek *θαλλὸς*, or Latin *thallus*, a budding twig,—a word which is frequently employed to express the beautiful green tint of young vegetation, chosen on account of the green line which it communicates to the spectrum, recalling with peculiar vividness the fresh color of early spring.

It appears from Crookes' researches that thallium is by no means a very rare substance; he has found it in many mineral ores from various localities. It was present in more than one eighth of the specimens in a large collection of cupiferous pyrites from different parts of the world—he has rarely found it however in pyrites in which copper was absent. In most cases it is only necessary to powder a small fragment of the mineral and ignite a little of it in the flame on a moistened platinum wire, when the green line is distinctly seen in the spectroscope. The author thinks that in some of the large English copper, sulphur and sulphuric acid works, thallium is now thrown away by the hundred weight: a slight modification of the present arrangements of the furnaces and condensing flues, or even an examination of some of the residues, would enable nearly the whole of this to be saved. Owing to the frequent occurrence of thallium in copper ores it is very probable that this element may sometimes be present in commercial copper and may give rise to some of the well known but unexplained differences of quality.

The author finds the following the most advantageous method for extracting the new element from sulphur or pyrites:—

Powder the ore very finely, and dissolve it as completely as possible in strong hydrochloric acid, with gradual addition of nitric acid until all solvent action ceases; then dilute with water, and filter. Evaporate down to drive off the excess of nitric acid, add a little sulphuric acid if necessary, and take care that the solution does not get dry, or even pasty. Then dilute with water, and heat gently, to be certain of getting all the soluble portion dissolved. Filter: if lead be present, the greater portion will be left behind in this operation in the form of insoluble sulphate. Dilute the filtrate considerably, and add a solution of carbonate of soda until the reaction is distinctly alkaline; then add an excess of solution of cyanid of potassium (free from sulphid of potassium). Heat gently for some time, and then filter. The precipitate contains the whole of the lead and bismuth which may be present as carbonates, whilst the thallium is in solution. A current of sulphuretted hydrogen now being passed through the liquid precipitates all the thallium, whilst the copper, antimony, tin, and arsenic remain dissolved. If cadmium and mercury are present, they will accompany the thallium. The former can readily be dissolved out by warm dilute sulphuric acid, which has scarcely any solvent action on the sulphid of thallium, whilst this in its turn can be separated from the sulphid of mercury by being boiled in moderately dilute nitric acid, in which the sulphid of mercury is insoluble. These two metals are, however, seldom present with thallium in the ores which I have examined. The nitric acid solution is now to be evaporated to dryness, the residue dissolved in hot dilute sulphuric acid, and a piece of pure metallic zinc placed in the liquid; the thallium will be at once precipitated in the form of a deep-brown powder, which soon changes to a heavy black, granular precipitate. The metal can be obtained in the coherent form by fusion in hydrogen.

This method of analysis is given on the supposition that all the above metals are present. It may generally be much abridged, as the ore is seldom of so complicated a character. If there is a difficulty in procuring perfectly pure zinc for the reduction of the sulphate to the metallic state, this can be effected by passing a weak voltaic current through the liquid, using platinum poles; the metal will then be precipitated in the reguline, or spongy state, according to the strength of the current. I have not been very successful in reducing the oxyd by hydrogen. The current of gas carries the volatile oxyd away from the heated part of the tube before complete reduction takes place. It is, however, probable, from an observation made towards the conclusion of this experiment, that, with a longer tube in proportion to the quantity of material, kept at a good heat throughout its length, this plan might give good results, the metal being considerably less volatile than the oxyd.

Mr. Crookes adds the following description of thallium and its chemical reactions and compounds, which we copy in full from his paper.

Thallium in the pure state is a heavy metal, bearing a remarkable resemblance to lead in its physical properties. Its specific gravity is, however, higher—about 12. The freshly scraped surface has a brilliant metallic lustre not quite so blue in color as lead, and it tarnishes more rapidly than this latter metal. It is very soft, being readily cut with a knife and indented with the nail; it may also be hammered out and drawn into wire, but has not much tenacity in this form. It easily marks paper. The fusing point is below redness, and with care several pieces may be melted together and cast into one lump. There is, however generally a loss in this operation, owing to its rapid oxydation. The metal itself does not appear to be sensibly volatile below a red heat. I have made no special attempts at present to determine the atomic weight, although from two estimations of the amount of sulphur in the sulphid it appears to be very heavy. The figures obtained did not, however, agree well enough to enable me to speak more definitely on this point, than that I believe it to be above 100. I may mention that I obtained this element in the pure metallic state and exhibited it to several friends as early as January last,* and should then have published an account of it, had it not been for the reasons already mentioned. Thallium is soluble in nitric, hydrochloric, and sulphuric acids, the former attacking it with greatest energy, with evolution of red vapors.

Oxyds of Thallium.—Thallium forms two, and probably three oxyds: one possessing basic properties, which I shall call the oxyd; another containing more oxygen, possessing acid properties, which may therefore be called thallic acid; and most likely a third, or suboxyd, which forms the first portions of the precipitate formed by zinc in solutions of this metal; the first action being a darkening of the solution, and the production of a deep-brown powder, which by longer contact with zinc turns to a dense black precipitate.

Upon carefully evaporating the nitric acid solution upon a water bath, but not carrying it to dryness, a mass of deliquescent crystals is obtained on cooling, which are decomposed upon addition of water with separation of a white or pale-yellow precipitate, which appears to be a subnitrate, and an acid solution containing nitrate of thallium. If the liquid is evaporated quite to dryness and kept at a temperature of 100° C. for a little time, the nitric acid goes off, and leaves a residue of thallic acid.

* Vide Chemical News, vol. v, pp. 349, 350.

Thallic Acid.—This acid is soluble in water, and may be obtained in the crystalline form from its aqueous solution. It then forms crystals, which are permanent in the air, and have an acid reaction to test-paper. The thallates of the alkalies are also soluble in water, and may be prepared by dissolving the acid in the alkali, or by fusing thallium or its oxyd with a mixture of alkaline carbonate and nitrate. The method I originally published for extracting thallium was based upon the formation in this manner of an alkaline thallate soluble in water. This acid is also produced in solution when permanganate of potash is added to a soluble salt of oxyd of thallium.

Chlorid of Thallium.—If a current of dry chlorine is passed over precipitated thallium at a moderate heat, they combine with formation of a volatile chlorid, which condenses in the cool part of the tube in the form of a pale-yellow crystalline powder, fusing together in parts to a crystalline lump. Water only partially dissolves this, with production of a white insoluble residue. Dilute hydrochloric acid added to the turbid solution immediately renders it clear; upon evaporating this solution over a water-bath, white crystals of the chlorid are deposited. When the nitric acid solution of thallium or its sulphid is evaporated with an excess of hydrochloric acid, and then more hydrochloric acid added and the evaporation repeated to a syrup, a residue is obtained which is apparently decomposed by water with production of a white precipitate: this is chlorid of thallium; it is insoluble or nearly so in water, but readily soluble in dilute hydrochloric or nitric acid.

Sulphid of Thallium.—When sulphuretted hydrogen is passed through the acid solution of chlorid of thallium, a partial precipitation of a reddish-brown powder takes place; this appears to be a combination of the chlorid and sulphid, and the metal is never entirely removed from solution by this means. The best method of obtaining the sulphid is to precipitate it with sulphid of ammonium in an alkaline solution; unless a large quantity of thallium is present, no immediate effect is produced beyond the darkening of the liquid; it assumes a brown tint, which becomes rapidly more and more intense, especially upon gently heating it, until the sulphid of thallium separates in the form of a deep brown heavy precipitate which shows a great tendency to collect together in clots at the bottom of the vessel: this formation of the sulphid is very characteristic of the metal. Sulphid of thallium is insoluble in an excess of sulphid of ammonium, ammonia, or cyanid of potassium. Its complete precipitation as sulphid from solutions containing an excess of cyanid of potassium affords a ready means of separating thallium from several metals with which it is frequently associated. It is difficultly soluble in hydrochloric or sulphuric acids, but readily so in nitric acid. When dry, it is a deep-brown, almost black powder, fusing and volatilizing when heated: when pure, it is neither so fusible nor so volatile as sulphur; but when it occurs with an excess of this lattter element, it is very difficult to separate from it by sublimation.

Carbonate of Thallium is precipitated upon adding an alkaline carbonate to the acid chlorid solution; it is moderately soluble in an excess of carbonate of ammonia, and readily so in cyanid of potassium. This is a very definite reaction, and enables thallium to be separated with accuracy from lead and bismuth.

Sulphate of Thallium.—When the hydrochloric or nitric solution is evaporated down with sulphuric acid, the more volatile acid is driven off and the sulphate is left behind. It is crystalline and soluble in water.

Iodid of Thallium is precipitated as a yellowish-red powder upon cautious addition of iodid of potassium to a solution of thallium. It is readily soluble in excess of iodid of potassium, forming a colorless solution.

Phosphate of Thallium forms a white flocculent precipitate soluble in mineral acids, but sparingly soluble in acetic acid.

Ferrocyanid of Thallium is white and insoluble in water.

Cyanid of Thallium is precipitated as a white or light-brown powder upon the cautious addition of cyanid of potassium to a solution of thallium. It is readily soluble in an excess of the precipitant.

Chromate of Thallium is a pale-yellow precipitate soluble in acids and re-precipitated upon neutralization with ammonia.

No precipitates are produced when a solution of thallium is mixed with *protochlorid of tin, oxalic acid, carbazotic acid, sulphurous acid*, or *protosulphate of iron.*

The reactions are sufficient to prove chemically that the body under examination is a new element. Its behavior in the spectrum apparatus is perhaps the most conclusive test upon this point. When a minute portion of the metal (the sulphid, chlorid, or in fact, any compound of thallium) is introduced into the flame of the spectroscope, it immediately produces a single green line, perfectly sharp and well defined upon a black ground, and of extraordinary purity and intensity, almost equal to the sodium-line in brilliancy. It is not, however, very lasting. Owing to its great volatility, a portion introduced at once into the flame merely shows the line as a brilliant flash, remaining only a fraction of a second; but if it be introduced into the flame gradually, the line continues present for a much longer time. If, also, a piece of metallic thallium be introduced into the flame on a platinum wire loop, they fuse together, and the alloy gives the green line rather more permanently, although of course fainter.

Working on a small scale, it is not easy to obtain these compounds free from soda; but when that is effected, and a tolerable quantity of substance is held on a loop of platinum wire in a flame, the green color is most brilliant, and produces very extraordinary effects upon the appearance of surrounding objects. If thallium could be obtained in quantity, this ready means of producing an intense and homogeneous green light could not fail to be applicable to some useful purpose.

The green line of the thallium spectrum appears to be unaccompanied by any line or band in other parts of the spectrum. A flame of sufficient temperature to bring the orange line of lithium into view produces no addition to the one thallium-line; and an application of telescopic power strong enough to separate the two sodium-lines a considerable distance apart still shows the thallium-line single. I consider therefore that I am justified in stating that thallium produces *the simplest spectrum of any known element.* Theoretical inquiries into the cause of the spectrum lines, and their relation to other constants of an element, may be facilitated now we know a metal which gives rise to luminous vibrations of only one degree of refrangibility. The remarkable simplicity of the thallium spectrum offers a strong contrast to the complicated spectra given by mercury, bismuth, and lead—the metals to which it has the most chemical resemblance.

The position of the green line does not coincide with any definite line in the solar spectrum. According to Kirchhoff's theory, we must therefore assume that thallium is not present to any great extent in the sun. Under the highest telescopic power of my apparatus, the line appears to be absolutely identical in refrangibility with a sharp well-defined line in the barium spectrum, to which Professors Bunsen and Kirchhoff have given the name Baδ. Want of material has hitherto prevented me from taking accurate measurements of the distance between the thallium-line and the principal lines of the solar spectrum.

This green line is an exquisitely delicate test for the presence of thallium, and shows it to be a somewhat widely distributed element. Many specimens of crude sulphur contain it (especially when rather dark-looking). In most cases it is only necessary to set fire to as large a piece of sulphur (less than a pea) as the platinium loop will hold, and when it has nearly burned away to blow it out, and then introduce it at leisure into the flame of the spectroscope, for the thallium to show its presence by a bright-green line which will flash for an instant into the field of view.

TECHNICAL CHEMISTRY.—

11. *For Photographic copying in pure Black and White.*—In copying maps, printed matter, engravings, &c., the following will be found an excellent method. After fixing a delicate negative, wash *very carefully*. Then flood with a solution of free iodine in iodid of potassium, two grains of the iodid to one grain of the iodine in the ounce of water. Dilute with water to a sherry pale color, or dark, as may be found necessary. Wash well and fix. Repeat the process, if necessary. The intensity of the color in the solution is a measure of the amount of iodine available. The liquid becomes colorless, by degrees; go on until it is quite colorless. To intensify, use Russell's developer for the tannin process, until experience shows you have sufficient intensity. Now immerse totally in bichlorid of mercury in acidulated water. One drop of nitric acid to six ounces of water. Wash very thoroughly. Flood with weak iodid of potassium, adding gradually to its strength until the deepest yellow with a tinge of olive color is obtained by transmitted light. Wash again, and treat with chlorid of gold, one grain to the ounce of water. E.

II. GEOLOGY.

1. *Observations on the Appalachian region of Southern Virginia;* by J. P. LESLEY (from an account of the Coal formation of Southern Virginia, in the Proc. Amer. Phil. Soc., Jan., 1862).—The coal region of Montgomery, Pulaski, Wythe, Washington, and Smith counties in Southern Virginia, is interesting in an economical as well as a geological sense. It furnishes species of semi anthracite and semi-bituminous coal, which come in competition with the Mesozoic bituminous coal of the Richmond basin, over the principal internal railroad of the Southern Atlantic States. This railroad penetrates the great primary range of mountains, the Blue Ridge, at Lynchburg, and then follows the course of the Great Valley, southwestward, to Knoxville and Chattanooga, in Eastern Tennessee. This Great Valley, of Lower Silurian limestone, extends from Newberg on the Hudson to Montgomery in Alabama, everywhere separating the range of the Blue Rridge, South Mountain, Smoky Mountain, or Black Hills, from the true Alleghanies or Appalachians. The rocks of the Blue Ridge range, on the eastern side of the Valley, are a prolongation of the Green Mountains of Vermont, and consist of the Quebec group or Taconic system, now understood by Logan to be a thickening of the lowest Silurian (Calciferous Sandrock and Potsdam Sandstone or Primal

Slates).* The Appalachian Mountains on its western side are Middle and Upper Silurian and Devonian formations. West of these rises the long high escarpment of the Carboniferous formation, forming the mountain plateau of Western Pennsylvania, Western Virginia, Eastern Kentucky, Central Tennessee, and Northern Alabama. The escarpment of this vast plateau, facing the east, and overlooking the Appalachian ranges, with their narrow, parallel, interval valleys, is the so-called Backbone Alleghany Mountain, beginning at Catskill on the Hudson, and ending in Alabama. The northern portion of this plateau is drained eastward by the branches of the Susquehanna, and westward by the branches of the Alleghany and Monongahela Rivers. All the waters of Middle Pennsylvani, Maryland, and Northern and Middle Virginia flow from the foot of this escarpment towards the Atlantic, breaking successively through the parallel Appalachian ridges of the subcarboniferous formations. The waters of the Tennessee River head also at the eastern foot of this escarpment, and flow along its base for several hundred miles southwestward, before they turn west at Chattanooga, and break through its southern extremity, to make their great circuit through Alabama, Western Tennessee, and Kentucky to the Ohio River near its mouth. But in the middle of the region, namely, in Southern Virginia, its normal drainage is reversed. The New River heads in the Blue Range, crosses the Great Valley westward, breaks *into* (not *out of*) the Appalachians, striking the escarpment in its face, and flowing directly through and across it (as the Great Kanawha) through Western Virginia into the Ohio.

The cause of this phenomenon is to be found in a change of structure at this line. Most of the valleys and mountains north of it as far as New Jersey are unbroken anticlinals and synclinals. Most of the valleys and mountains to the south of it, as far as Alabama, are monoclinals, bounded by immense faults or downthrows.

The Appalachian Mountains of Southern Virginia and Eastern Tennessee are grouped in pairs by these faults. The country for three or four hundred miles northeast and southwest, and from thirty to forty miles from southeast to northwest, is fractured in parallel strips from five to six miles wide. Each strip is tilted at such an angle (dipping southeast) that at each fault the upper edge of one strip (with its Carboniferous rocks) abuts against the bottom or Lower Silurian edge of the strip next to it. As the Palæozoic system, thus revealed (on edge) between any two of these faults, contains two massive sandrock formations, No. IV, Middle Silurian, and No. X, Upper Devonian, there occur necessarily between each pair of faults a pair of parallel moutains. The Palæozoic zone, therefore, included between the Great Valley and the Backbone escarpment, is occupied by as many pairs of parallel mountains as there are great parallel faults: and as these faults range in straight lines at nearly equal distances from each other, these mountains run with remarkable uniformity, side by side, for a hundred or two hundred miles, and are finally cut off, either by short cross faults, or by slight angular changes in the courses of the great faults. Thus we get an explanation of the

* It is but just, to say that the Professors Rogers maintained substantially this view before 1840, considering, as they did, the Blue Ridge System an enlargement merely of Formation No. I.

very unusual arrangement of the head waters of the Tennessee River, in long parallel branches, with few subordinate affluents, suddenly uniting through mountain gorges, or at the ends of long mountains.

In each pair of Palæozoic mountains the eastern one carries a coal area on its seaward flank; because, the last formation to dip against each fault is the Coal at the top of the series, abutting against the Lower Silurian of the limestone valley which always exists on the eastern side of the fault.

The coal here, however, is not the coal of the Carboniferous formation, commonly so called.

Underneath the true coal measures of Pennsylvania, Ohio, and Northwestern Virginia, and underneath the Millstone Grit Conglomerate (No. XII) at its base, and the Red Shale formation (No. XI), which underlies the last, there begins, even in Pennsylvania, to appear an older coal formation, connected with the uppermost Devonian, white, mountain Sandstone, No. X. It is seen in one or two beds two feet thick at the head waters of the Juniata. It is mined where the Monongahela waters cut through Chestnut Ridge from Virginia into Western Pennsylvania. It has been mined in the mountains on the Potomac *below* Cumberland. It appears occasionally in Northern Middle Virginia, on the western side of the Great Valley of Winchester. It increases in importance along the western outcrop of the great coal field through Eastern Kentucky, until it enters Tennessee. It seems, however, to obtain its maximum development in Montgomery county, on the New River, in Southern Virginia, near the line of our section. Here it is seen to consist of two principal coal-beds and several minor seams. The lowest bed reaches the thickness of four feet, and the next one above it is in some places nine feet thick. In the Peak Hills, just east of Wythe, along the line of the railroad, numerous lenticular deposits of coal are seen, and thin distorted beds, the whole composing a formation several hundred feet thick. Near the New River, the two beds above-mentioned are seen to be covered by at least a thousand feet of Red Shale; upon which rests a Subcarboniferous limestone; which abuts, at the fault, against other limestones belonging to the Lower Silurian age. Between Christiansburg and Blacktown, north of New River, a regular synclinal coal-basin has been preserved for a few miles upon the eastern side of the great fault, which crosses the river in front of the gap. In this coal-basin the two beds of coal are preserved, but in a crushed condition. To the southwest, two faults cut off a similar short basin from the regular coal formation on the mountain, throwing up a wedge of Lower Silurian Limestone.

It is here that the relationship of these great faults to the normal anticlinals and synclinals of the Appalachian region can be studied to great advantage; the presence of cross faults at high angles being exhibited by the sudden termination of the mountains, and by the tearing open, as it were, of one side of anticlinal coves.

2. *Dyas, order die Zechstein formation und das Rothliegende,* von Dr. Hanns Bruno Geinitz, Director des Kön. Min. Mus., und Professor an der Polytech. Schule zu Dresden, etc., mit Beiträgen der Heeren Robert Eisel, Rudolph Ludwig, Dr. August Em. Reuss, Der Reinhard Richter u. A. Heft. II, Der Pflanzen der Dyas und Geologisches. 210 pp. 4to,

with 19 lithographic plates.—This volume is the concluding part of the great work on the Permian, noticed in the September number of this Journal. It contains an account of the Fossil botany of the Permian, illustrated by 11 quarto plates; and following this, descriptions of the Permian formation in Saxony, Silesia, Bohemia, Thuringia, Western Germany, Russia and other parts of Europe, and Great Britain. An Appendix includes an Index Plantarum and a long table showing the geological and geographical distribution of the Permian in Europe. This work of Dr. Geinitz should be in the hands of all who would understand the Geology of the Permian period,—a period having a special interest from its relations to both the Palæozoic and Mesozoic eras. While essentially belonging with the former, it is the transition period between the two. The recent discovery of Permian beds west of the Mississippi renders the work of additional interest to American geologists.

3. *On the footprints of Limulus as compared with the Protichnites of the Potsdam Sandstone;* by J. W. Dawson, (Canadian Naturalist).—In this paper Mr. Dawson compares the impressions called *Protichnites* (see Jour. Geol. Soc. London, vol. viii) with the tracks of a modern Limulus, illustrating the subject with figures. The following are his conclusions with regard to these Potsdam impressions:—

"(1.) The conjecture of Owen that they may have been made by a creature somewhat resembling Limulus, is verified by the impressions made by that animal.

(2.) The further view of Owen that the grouping of the impressions depended on multifid limbs, and that the number of impressions in a group might indicate specific diversity, is also vindicated by the facts, with this limitation, anticipated by Prof. Owen, that tracks like *P. lineatus*, might have been made by any of the animals which made the other impressions, and that if like Limulus they possessed one large pair of feet making the principal marks, and smaller ones occasionally used, the numbers of marks may have somewhat differed in different circumstances. Still it is evident that a species of Limulus having a different number of divisions of the posterior toes, from that to which these remarks relate, might be distinguished by its footprints.

(3.) The animal or animals producing the Protichnites probably resembled Limulus in general form, and in the possession of a strong caudal spine. They probably differed from Limulus in the less breadth or depth of the cephalo-thorax, and in the greater complexity and comparative size of the feet.

(4.) Some at least of the Protichnites were probably produced by animals creeping on wet sand; but *P. lineatus* and the *Climactichnites*, if the work of a similar animal, were formed under water. This accords with the view entertained by Sir W. E. Logan as to the conditions of deposition of the Potsdam sandstone; and it is probable that these ancient Crustaceans, like the modern Limulus, frequented the sandy beach for the purpose of spawning, and may sometimes have been left dry by the tide.

(5.) The suppositions above stated would account for the absence or rarity of remains of the animals which produced the Protichnites. It is rare to find on the modern beach any fragment of an adult Limulus, except on the dry sand above high-water mark. The creatures are driven on shore only in storms, and then, owing to the lightness of their crusts, are drifted high on the beach. The remains are probably to be found in circumstances favorable to their preservation, only on the muddy bottoms at a distance from the sandy shore. Young individuals appear to frequent the sand only in summer, and occasionally to be imbedded in it.

(6.) If we inquire what animals, known to palæontologists, have produced the Protichnites, it would seem that no others fulfill the necessary conditions in any particular, except the larger trilobites, for instance those of the genus *Paradoxides*. It is true that we know nothing as yet of the feet of these creatures, but it seems almost certain from analogy that they must have possessed such organs. Nor have these trilobites a caudal spine like that of Limulus; but here again Mr. Billings points out to me that the pygidium of Paradoxides is narrow and spine-like, though I should think not sufficiently so to form the very distinct median groove of Protichnites, unless indeed the animal was in the habit of walking with this organ pointed downward. On the whole we may safely conclude that if any of the larger Primordial trilobites were provided with walking and swimming feet of the type of those of Limulus, but differing in details of structure, they may have produced both the Protichnites and the Climactichnites. On the other hand, it is quite probable that these impressions have been formed by Crustaceans yet undiscovered, and approaching in some respects more nearly to Limulus than any of the known trilobites. In this last case I should suppose that the animal in question had a flatter or more shallow cephalo-thorax than that of Limulus, proportionately stronger and perhaps more divided feet, and a stouter caudal spine.

It is scarcely necessary to observe that the footprints of Limulus differ materially from those of the higher Crustaceans, and also from the galleries formed by many small burrowing Crustaceans. With these last Mr. T. Rupert Jones, in an interesting article in the "Geologist" for April, seems disposed to compare *Climactichnites Wilsonii;* but this appears to me to have more the character of a surface impression, though what appear to be galleries of small Crustaceans are also found in the Potsdam sandstone. The '*Nereites*' of Emmons,* from the Taconic rocks of that author, also resemble in some respects the sub-aquatic trails of Limulus, and may be the work of Trilobites; and the same remark applies to some of the markings from the Clinton of New York, figured by Hall,† and referred to Crustaceans and worms."

Note.—It appears very improbable that the fossil Paradoxides, like other Trilobites, would be so uniformly deprived of stout limbs, if the living animal had them; for limbs that could make the very large tracks of the *Protichnites*, would hardly fail to become fossilized. The reference of the *Chimactichnites* tracks to the Paradoxides is in all probability right. The same opinion is expressed by the writer in his Manual of Geology in a paragraph printed six months since, though the work is but just now leaving the press. J. D. D.

* Agriculture of New York, vol. i.
† Palæontology of New York, vol. ii, Pl. 13 to 16.

4. *Fifteenth Annual Report of the Regents of the University of the State of New York on the condition of the State Cabinet of Natural History, &c.*, made to the Legislature April 12, 1862; 8vo, pp. 170. Albany: C. Van Benthuysen, 1862.—This Report contains the continuation of Prof. Hall's Palæontological researches. The larger part of the memoir has been already noticed briefly in former issues of this Journal, vol. xxxii, 430, Nov., 1861, and in this volume, p. 282. It is enriched by numerous figures in the text and by eleven plates of fossils, two of them on stone. One of the latter is a reproduction of a plate of Mr. Conrad's to vindicate himself and Mr. C. from the criticisms made by Mr. Billings of the Canadian Survey, upon the genera *Cypricardites* and *Modiolopsis*.

The last page of the report contains a letter from Col. E. Jewett, Curator of the State Cabinet, announcing an important observation made by that gentleman on the age of the "Catskill group." The same information has been communicated to us in a letter from Col. Jewett, but we copy from the official document as follows:

"Albany, September 20, 1862.

Dr. S. B. Woolworth, *Secretary of Regents*, &c.—Sir:—Agreeable to your directions, I went to Delaware county, to collect fossils from the Catskill group, or Old Red Sandstone.

At Franklin I found Mr. J. M. Way, a gentleman who for years has been examining the rock and collecting the fossils; and although he is unacquainted with any other localities, and has never seen a collection of fossils, he has succeeded in investigating the whole strata of the neighborhood and collecting many fossils. With his assistance, I was able to make a section from the Oleout creek to the top of a hill about three miles southwest of the village of Franklin, more than 800 feet in thickness. The base is a brick red shale, with occasional red argillaceous sandstone, about 400 feet. On this is about fifty feet of greenish shale; on which lies a stratum of gray sandstone, with teeth and plates of fishes, and fossils of the *Chemung group*. Seventy feet of green shale lie on this fossiliferous stratum; when another thin band of fossils, with gravel and the same formation, continues with alternate shale and gray sandstone and fossils to the top of the hill, where the Chemung fossils are more numerous. Spirifers, Rhynconellas, Pectens and Athyres are found in all the strata of the upper three hundred feet, and the whole formation is undoubtedly Chemung.

I examined other localities with the same result.

Mr. Way has examined the rock as far as Deposite (twenty-five miles southwest), with great care, and finds the same formation. He has also collected the same fossils at Delhi, seventeen miles southwest.

From my investigations, I believe that there is no Old Red Sandstone [Catskill formation] in this State. * * *

* * * * * * *

Respectfully, &c.

E. Jewett."

III. BOTANY AND ZOOLOGY.

1. *Dimorphism in the Genitalia of Flowers.*—Two principal kinds of this dimorphism have been noticed in a great number of instances, and put on record in various works; but the instances have not been collected and systematized, nor had the import of the most curious case been made out until it was recently elucidated by Mr. Darwin. There is, first, the dimorphism which Mr. Darwin has recently illustrated in his paper "On the two forms, or Dimorphic Condition, in the species of *Primula*," which was briefly noticed in the preceding number of this Journal (p. 285). This was here long ago named *diœcio-dimorphism* (see Flora N. America, ii, p. 38, etc.); a name which pretty well expresses the thing, as now understood, for these blossoms although hermaphrodite structurally are functionally as if diœcious, or nearly so, the end subserved being fertilization of the ovules of one flower by the pollen of another flower on another individual.

The diœcio-dimorphous species of *Plantago* had seemed to confuse this case with the next. That is, the short-stamened flowers appeared to be fertilized in the closed flower, and the long-stamened and generally sterile plants therefore to be generally useless. This could hardly be; and a recent observation on a single specimen (likely to be confirmed in others) shows the top of the style projecting from the tip of the closed corolla. This refers the case to the same category with *Houstonia*, *Primula*, &c., to which *P. prisella* and *P. heterophylla*, having the corollas of the short-stamened form open in anthers, and the stigma projecting, evidently belong. It is to be noted that dimorphism, both of this and of the following sort, is apt to be variable either in mode or in degree in different species of the same genus, and also that it seldom occurs in all the species of a genus, some of them being unaffected, while others in some genera are nearly polygamous or diœcious;—which is all very favorable to the conclusions that Mr. Darwin wishes to draw.

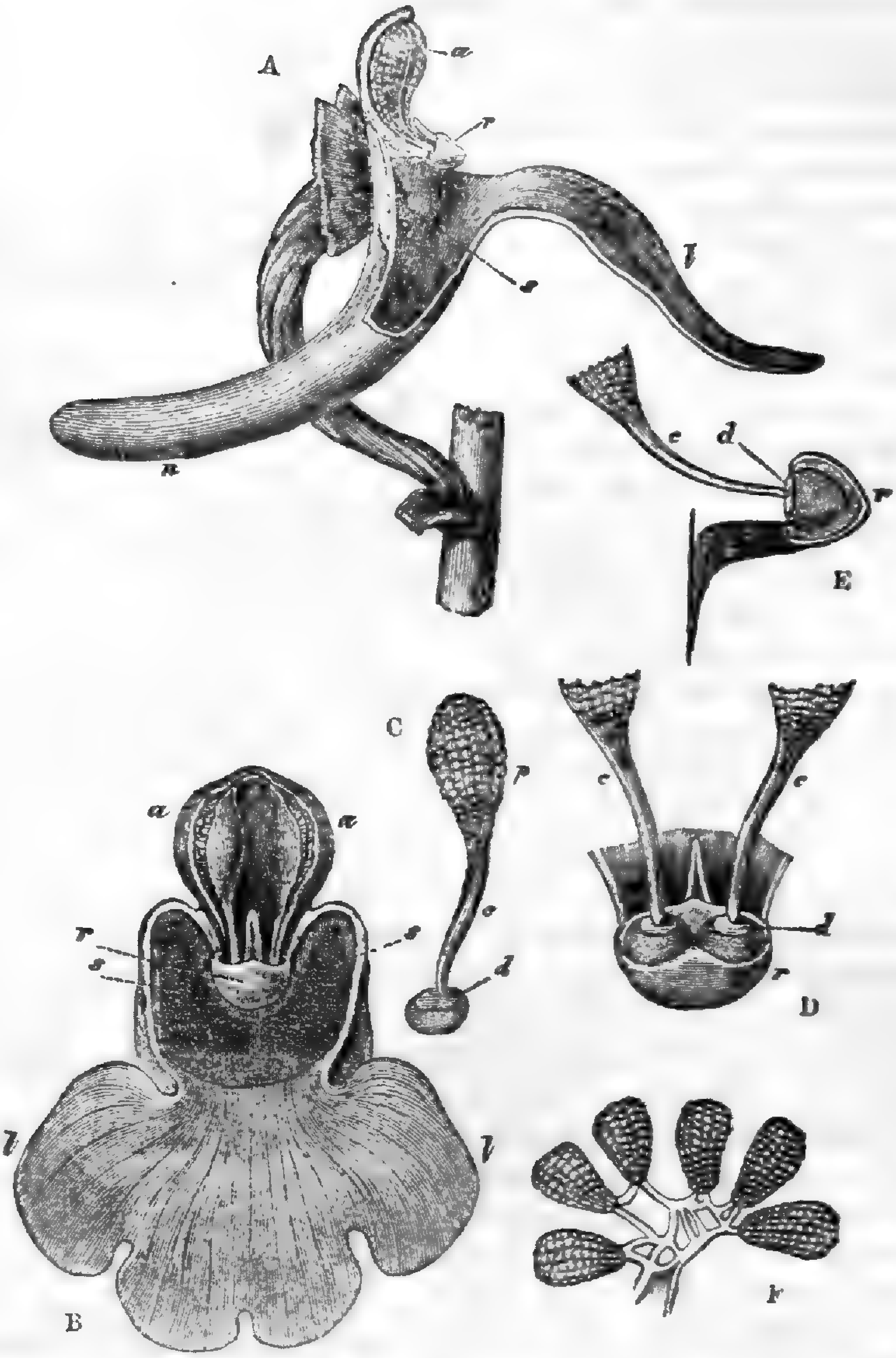
The second case, which equally belongs to structurally hermaphrodite flowers, is practically the reverse of the first. It is the case in which, besides the normal flowers of the species, which for the most part are rarely or sparingly fertile, other flowers are produced which never open, their development being as it were arrested in the bud, but which are very prolific of seed. Here the stigma is, and must needs be, fertilized by pollen from the anthers of the same flower, the two being shut up together in the same closed bud. The acaulescent Violets and the common wild species of *Impatiens* are good examples of the kind. In fact, here impregnation is effected as it were in the early bud;—wherefore we had indicated these as cases of *precocious fertilization*. Here the pollen is unusually active, sending out its tubes while still in the anther, and thereby in *Impatiens*, &c., attaching the anthers to the stigma. In the first case Nature takes great pains to secure the cross-fertilization of individuals of the species: in the other, on the contrary, she takes equal pains to secure self-fertilization. The end in the first case, as Mr. Darwin maintains, (we believe upon good philosophical grounds, now in the course of vindication by experiment) is to ensure the perpetuation of the species, since close-breeding or continued self-fertilization tends to sterility, while wider breeding is recuperative. We leave it to Mr. Darwin's sagacity to ascertain the end in the opposite case, noting that here the most undoubted close-fertilization for indefinite generations shows no apparent tendency towards sterility, but rather the contrary.

From another point of view which we are accustomed to take, however, we may suppose that, as one result the cross-fertilization must needs be to keep down variation by repeated blendings, so the design of close-fertilization may be to allow and to favor the perpetuation of varieties. Self-fertilization, without selection, being just the condition which should most favor both the multiplication of new varieties and their preservation. That such would be the operation (as long ago expounded in this Journal, vols. xvii and xix) appears to us so clear, that we were somewhat surprised at finding that the reviewer of Darwin's *Primula*-paper in the Natural History Review (ii, p. 238) regards the separation of sexes, and therefore cross-fertilization, as favoring variation, and self-fertilization as necessarily inimical to it. This probably comes from not considering that while close-breeding tends to keep a given form true—in virtue of the ordinary likeness of offspring to parents—it equally and in the same way tends to perpetuate a variation once originated from that form, and also, along with selection (natural or artificial), to educe and further develope or confirm said variety. On the other hand, free cross-breeding of incipient varieties *inter se* and with their original types is just the way to blend all together, to repress all salient characteristics as fast as the mysterious process of variation originates them, and fuse the whole into a homogeneous form.

We will also remark (in reference to p. 236, line 31, and p. 238, line 3 et seq. of the above mentioned Review) that the Chestnut does exhibit manifest rudiments of stamens in its pistillate flowers; also that, on morphological grounds, we should look upon hermaphroditism, rather than the contrary, as the normal or primary condition of flowers, and enquire how and why so many became diclinous, rather than "how and why they ever became hermaphrodite." Forms which are low in the scale as respects morphological completeness may be high in the scale of rank founded on specialization of structure and functions. A. G.

2. *Fertilization of Orchids through the Agency of Insects.*—In our notice of Mr. Darwin's charming new work, in the July number of this Journal, we could not get beyond the first two chapters, relating to the *Ophrydeæ*, or the tribe to which the Orchises themselves belong. Those of our readers who, appreciating the treat to which they were invited, have been looking into our Orchideous flowers, will not be sorry to have us resume the subject.

In default of drawings from some of our own species, which we should prefer if we had them, we borrow the cuts with which the author illustrates the two British species (*Orchis mascula* and *O. pyramidalis*) with the account of which Darwin's book, and our abstracts, commenced. These figures should render those abstracts much more intelligible. The small letters denote the same thing in all the figures.



a, anther; *r*, rostellium; *s*, stigma; *l*, labellum; *n*, nectary; *p*, pollinium or pollen-mass; *c*, caudicle of pollinium; *d*, viscid disc of pollinium.

A, is a side view of a flower of *Orchis mascula*, with all the petals and sepals cut off except the labellum, of which the near half is cut away, as well as the upper portion of the near half of the nectary.

B. Front view of the flower, with all the sepals and petals removed, except the labellum.

C. One pollinium, or pollen-mass, showing the packets of pollen-grains, the caudicle, and the viscid disc.

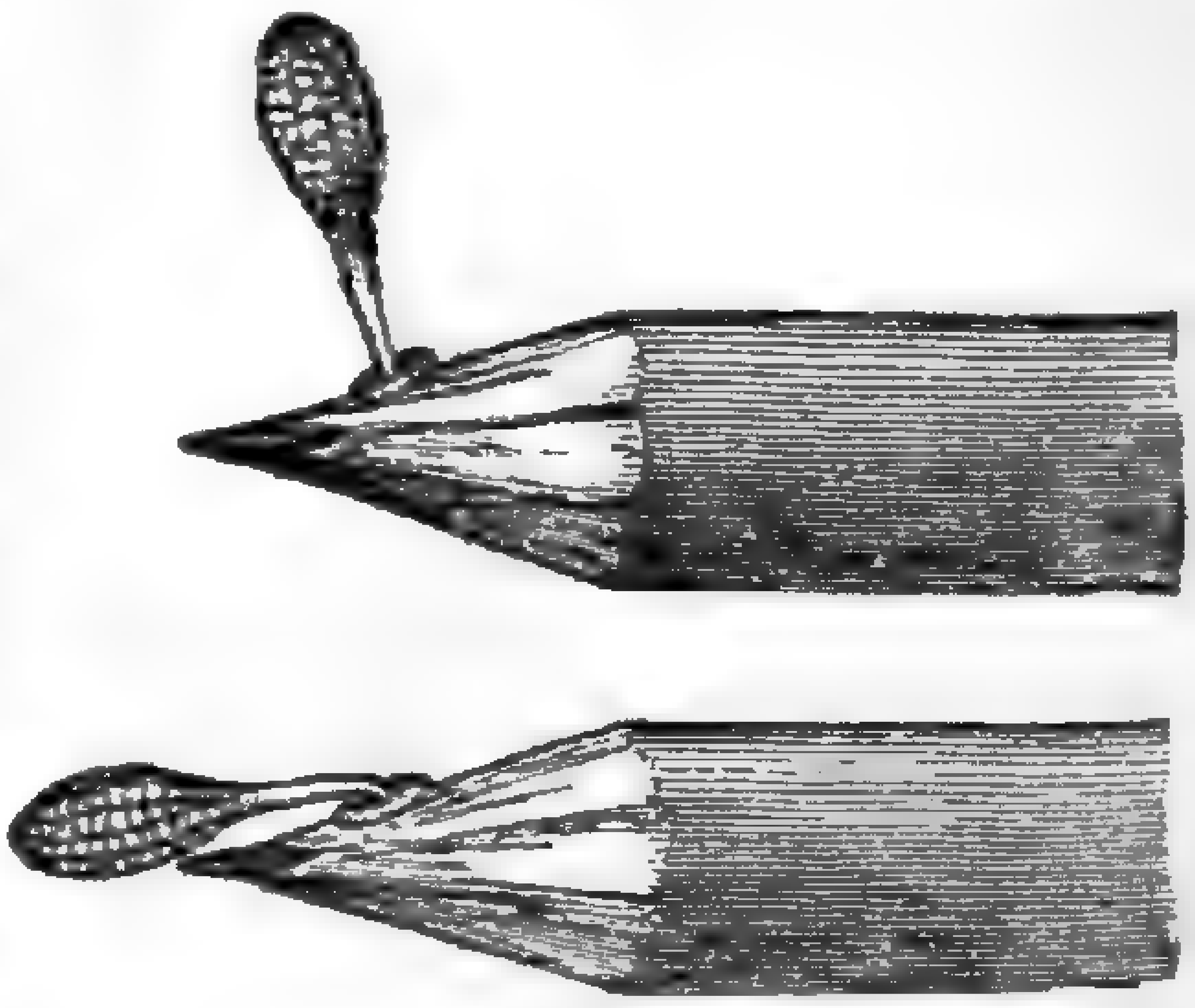
D. Front view of the discs and caudicles of both pollinia within the rostellum, with its lip depressed.

E. Section through one side of the rostellum with the included disc and caudicle of one pollinium.

F. Packets of pollen-grains, tied together by elastic threads, here extended.

The general structure of the flower in this species will be found to correspond very well with that of our *O. spectabilis*.

Now, supposing one of the pollen-masses to be removed from the flower by the insertion of the point of a pencil into the orifice of the nectary, on withdrawing the pencil, the pollen-mass, adhering by its viscid disc, will be found to stand as represented in the accompanying figure G. But in a few seconds a movement of depression takes place, through which the pollen-mass is brought invariably into the position represented in figure H. And now, upon again inserting the point of the pencil into the orifice of the nectary, the pollen mass will be brought into contact with the glutinous stigma, to which some of the pollen-packets will certainly adhere.

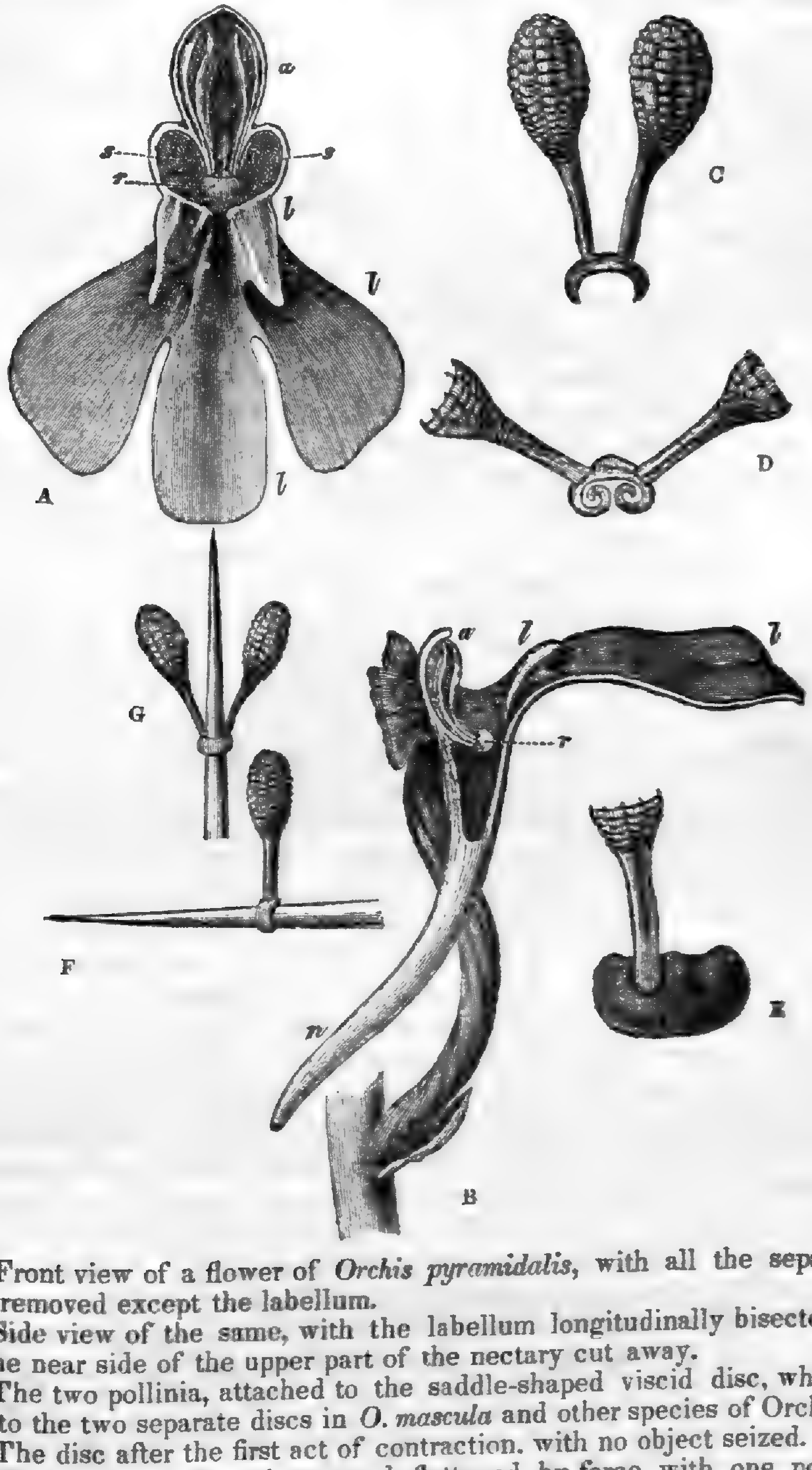

G
H

The following figures relate to *Orchis pyramidalis*, and our extracts should be read anew in connection with the illustrations. The small letters, as far as they go, indicate the same parts as in the foregoing illustrations. (See page 423.)

The egg having once been set on end, any body can do the feat, with more or less dexterity. At least every person should make observations according to his opportunity; although their interpretation will often task even Mr. Darwin's sagacity. As our present contribution, we proffer a few notes upon some of the Orchids of our district,—giving due warning, however, that our observations, made during the past summer, were so hurried and casual that they must not be too much relied upon. They may serve a purpose in directing the attention of others to the subject.

Having sufficiently described the arrangements for insect agency in the fertilization of *Platanthera Hookeri* (this volume, p. 143), we will now turn to its relative,

Platanthera orbiculata, one of our most striking species. Of this we first received some spikes in early bud,—in which state it is plain to see that the discs of the pollinia are an integral part of the stigma, their viscid surface being then continuous with that of the stigma. It may be worth mentioning that these spikes, stuck into a glass of water for eight or ten days, developed many of their flower-buds tolerably well, excepting the spur, which instead of elongating remained a scrotiform protuberance,—an 'arrest of development'—and at length sphacelated. The full-grown spur in this species being an inch and a quarter or an inch and a half long, and the divergent bases of the anther-cells so separated by the broad stigma that the viscid discs stand nearly a quarter of an inch apart, it is evident that fertilization is effected by the agency of large Lepidoptera or Hymenoptera. Self-fertilization is out of the question. Here the labellum is pendent, inviting a front approach, while the lateral petals, as is usual in this tribe, guard against a flank movement. The way in which the anterior portion of the anther-cells with the combined arms of the stigma taper and project forwards, so as to raise the discs on a sort of beak, a little in advance of the orifice of the nectary, is well exhibited in Hooker's figure of this species, in the Flora Bor. Amer.: but the discs do not look outwardly in the manner there represented. These, being affixed to the stalk of the pollen-mass laterally, by that intermediate body called the drum-like pedicel, (here developed perhaps even more than in *P. Hookeri*,) really look forward and inward—in fact are so placed that they will be sure to stick one to each side of the head of a humble-bee or of a large moth that visits the flower, and thrusts its proboscis down into the spur so as to reach the nectar. The movements of rotation and depression in our floweiing specimens (all received from a distance) were pretty slow, but distinct.



A. Front view of a flower of *Orchis pyramidalis*, with all the sepals and petals removed except the labellum.

B. Side view of the same, with the labellum longitudinally bisected, and with the near side of the upper part of the nectary cut away.

C. The two pollinia, attached to the saddle-shaped viscid disc, which answers to the two separate discs in *O. mascula* and other species of Orchis, &c.

D. The disc after the first act of contraction, with no object seized.

E. The disc seen from above, and flattened by force, with one pollinium removed,—showing the depression by which the second act of contraction is effected.

F. The pollinia removed by the insertion of a needle into the nectary, after it has clasped the needle by the first act of contraction: side view.

G. The same pollinia after the second act of contraction and depression.

Platanthera ciliaris and *P. blephariglottis*, the Yellow and the White Fringed Orchis, flowering after midsummer, are as similar in their arrangements for fertilization as in general appearance. Under the present point of view, they are chiefly remarkable for having their viscid discs projecting much more even than in *P. orbiculata*, the anterior part of the anther-cell and the supporting arm of the stigma united (but readily separable, more plainly than in other species showing what belongs to each) tapering and lengthened to such a degree that the viscid discs are as if raised on a pedicel or tentacle, projecting considerably beyond the rest of the column. The anther-cells are nearly horizontal, and greatly divergent, but inclined somewhat inwards at the end; so that the discs are presented forwards and slightly inwards,—at least in *P. blephariglottis*, or in *P. ciliaris* more directly forwards. Evidently these projecting discs are to be stuck to the face or head of some nectar-sucking insect, of appropriate size, that visits the flowers. The stigma, which is rather small, is between the lateral arms, in the same horizontal line with the discs: the discs are small, but quite sticky, and directly affixed to the extremity of a caudicle or stalk which, in just proportion to the forward elongation of the anther-cell, &c., is remarkably long and slender, twice or thrice the length of the pollen-mass it bears. Upon removal by the head of an insect or any convenient foreign body, a slight bending or turning of the slender caudicle brings the pollen-mass into position for reaching the stigma. The discs, in ordinary flowers of *P. ciliaris*, are about a line and a half apart; the slender spur an inch long;—from which somewhat of the nature and size of the insect adapted to the work in hand may be estimated.

Platanthera fimbriata, the earlier Purple Fringed Orchis. In this the two lateral divisions of the labellum aid in hindering a lateral approach, while its middle division offers a convenient landing-place in front. The contracted base of the labellum is grooved, or with incurved margins, the trough leading as a sure guide to the narrow orifice of the nectary. The two anther-cells are widely separated, but little divergent; their anterior ends projecting strongly forward, the naked discs are brought just into line with the orifice or the nectary. The pointed tip of a pencil brought to the orifice of the latter, neatly catches the sticky discs and brings away the pollinia; when the movement, which is effected within a quarter or a third of a minute, converges them just enough to make them hit the broad stigma (which lies rather high) upon the re-application of the pencil. The 'drum-like pedicel' is present in this species also, but reduced to a minimum: the movement which takes place appears to result wholly from its change of form, the portion towards the anther contracting most, and to be one of depression solely.

Platanthera psycodes, the later and small-flowered Purple Fringed Orchis, is so nearly related to the last as by many to be regarded as a variety of it. It is more decidedly sweet-scented; and the claw-like base of the labellum is only slightly grooved. A development of the sides of the column as a kind of guard protects the discs laterally in this as in several other species, especially the last and *P. lacera*, preventing all ready access to the nectary except from the front. A stout bristle, slid along the base of the labellum and into the nectary for some distance will not touch the viscid discs, they lying a little too far back: but on pushing it down deep into the long and curving spur (only the lower half or quarter of which is filled with nectar) it has to be bowed back somewhat, when it catches the discs. So that before an insect can have drained the nectary, the pollinia will be affixed to the base or upper part of its proboscis, or to the forehead of an insect of smaller size. When extricated, the movement of depression is prompt—within a few seconds,—and on re-application the pollen is accurately brought in contact with the stigma. The discs in place look forwards and downwards. We find in this species and in *P. lacera* (both common species and flowering at the same time in the latter part of summer), that the nectar appears to be much more plentiful in the spurs of older than of freshly-opened blossoms, most so indeed in flowers which had their pollina removed and their stigma fertilized several days before, and which were becoming effete. In such flowers the spur was often half full in the present species, and sometimes almost full in *P. lacera.* But although little had dripped down to the bottom of the spur in freshly-opened blossoms, the walls were moistened with nectar throughout its length.

Platanthera lacera, the Ragged Orchis, like the last, must be very attractive to some insects, the pollen-masses are so generally removed from oldish flowers, and the stigma fertilized. The nectary can be approached only from the front, the sides being thoroughly guarded by a broad and thick shield on each side—the arms of the stigma much developed—above supporting the anther, while its inner and concave face bears the remarkably long and narrow viscid discs: posteriorly, on its upper margin, a sort of cellular crest is developed. These guards come forward in front to within half a line of each other at the level of the discs; while above and below the space is wider. The viscid disc which adheres to the inner face of each guard or arm of the stigma, instead of orbicular and small, is lanceolate in shape, with the anterior end broadest, the posterior end acute: it lies transversely, with a slight obliquity: it is as long as the stalk of the pollen-mass, which is directly attached to it near the middle, no 'drum-like pedicel' intervening. When detached by a probe or bristle brought in contact with the viscid disc, a movement of depression takes place, by which the stalk and pollinium are brought down so as to be nearly parallel to the disc, and close to it,—just in proper position to reach the stigma upon bringing the probe back again to the orifice of the nectary.

Platanthera dilatata. The general structure of the flower in this species we had occasion to describe in the preceding number of the Journal (p. 259): this need not be repeated. It accords wih *P. lacera* in having very large and strap-shaped viscid discs, but in no other respect. For in this the anther-cells are appoximate and nearly parallel; and the discs are parallel and vertical, approximate, and placed just over the back side of the narrow orifice of the spur, looking forwards; they are nearly as long as the pollen-mass and its stalk together; the latter is short and flat, and is attached to its disc just below the summit of the latter. No movement of depression or of rotation was detected. The throat of the flower is a narrow chamber, bounded by the connivent-erect bases of the parts of the perianth; and the stigma and the discs lie so low in this chamber that fertilization cannot be effected without insect-aid, and this can be given only by means of a proboscis. We find accordingly that a pig's bristle cannot be thrust down to the bottom of the spur and withdrawn without bringing away one of the pollinia. But the anther-cells are very early dehiscent, and the pollinia are often dislodged as soon as the flower opens. Yet from the arrangement of the parts, we think they can never fall over upon their own stigma, as they habitually do in the allied—

—*Platanthera hyperborea.* We have elsewhere stated (this volume, page 260) this species readily, and so far as we could ascertain from a few specimens, regularly *self-fertilizes* and without extraneous aid. We have nothing important to add to the brief account of the structure and process already described,—except that the packets of pollen are looser and the threads that attach them to the caudicle weaker than usual; while the discs (which are oval and rather small) retain for a good while their viscidity. So that a fitting insect, on visiting the open flowers, in which the pollen-masses have already fallen over on to the broad stigma underneath, will yet catch one or both the discs upon his proboscis, carry off the pollinia (which may be readily detached from the stigma, leaving some packets of pollen behind), and apply them in succession to the stigmas of other flowers of other individuals, and thus effect occasionally the crossing which is so uniformly effected in most species of the tribe. If the rule holds here as elsewhere, that a stigma is more sensitive to the pollen of another flower than to that of its own, there will be no lack of sufficient crossing in this species, wherever proper insects abound; where they do not, it will be prolific without them. We have observed that this species is very fertile, usually maturing all its ovaries. *Natura non agit saltatim*, and is more flexible and diversified in her ways than we are apt to think: many other cases of occasional or habitual self-fertilization may be expected among Orchids.

Gymnadenia tridentata is an additional instance of the kind, as we have elsewhere intimated (p. 260, foot-note), and one apparently so remarkable that we hesitate to bring forward our too scanty observations until another summer affords an opportunity to test them. We may venture to say, however, that, although the anther-cells open before the flower expands, and the pollen-masses are often spontaneuosly dislodged, —the discs being still in place,—yet, so far as we can see, they cannot of themselves fall upon or reach the stigma beneath. To do this they must be conveyed, in the usual way, upon an insect's proboscis, and most probably they often are so conveyed from one flower to another. Also, the pollen-packets are still more loose and separable than in *Platanthera hyperborea ;* many of them are found spontaneously detached in the full-grown flower-bud or freshly expanded blossom, lying upon the open anther and adjacent parts, and especially upon the naked-cellular tip of the narrow process of the rostellum which rises between the two discs, and upon the cellular summit of the process outside of each disc. These are soft, moist, and somewhat viscid. The pollen which falls upon them adheres there, *and sends down pollen-tubes freely into their substance.* So that they appear to act as stigmas; although the normal stigma is found in its proper place and of ordinary appearance underneath the discs.

Having room for only two or three more brief notes, one of them shall be upon—

—*Goodyera.* We can only refer our readers to Darwin's description of *G. repens*, which is common in all our northern forests. We confirmed before we read Mr. Darwin's conjecture (on p. 114) "that the labellum moves farther from the column in mature flowers, in order to allow insects, with the pollina adhering to their heads or probosces, to enter the flowers more freely." Except that, if we mistake not, it is the column which changes its position, rather than the labellum. All freshly-opened blossoms have the column so directed—a little bowed forwards—that the tip of the *disc and of the anther* are presented to view as you look into the narrow opening of the flower; and a proboscis or bristle, introduced, and following as it will the curvature of the lip-like or nozzle-shaped apex of the labellum, and passed down to its saccate nectar-bearing base, will inevitably hit the disc, and if detained a moment, will bring the pollinia away when withdrawn. On re-introduction, the pollina will not pass down to the stigma, but lodge on the upper side of the column, from whence they were taken. But on looking into older flowers of the same spike, still fresh and good, and whether their pollina have been extracted or not, the *stigma* is in full view, the summit of the column (we believe) being now turned somewhat upwards or backwards; and there is now room enough between it and the labellum for the pollinia to pass; indeed now the pollinia will regularly hit the stigma, to which packets of pollen will plentifully adhere. So, as bees, &c. are said to begin at the bottom of a spike and to proceed regularly upwards, the pollen taken by them from the flowers of any spike will never fertilize other flowers of that spike, but will be carried to another plant, where it will fertilize the lower blossoms ready for it,—from which spike in turn pollen will be carried off to fertilize the flowers of a third plant, and so on!

Goodyera pubescens, although specifically quite distinct, accords with *G. repens* in all the above particulars.

Spiranthes, both *cernua* and *gracilis*, confirm Darwin's account: the difference in the position of the parts—the disc and anther presented in the younger, the stigma in the older flowers, just as in *Goodyera*—is so very striking that we wonder how we overlooked it last year. Here, also, we suspect that it is the column, rather than the labellum, which changes its position, but we have not been able to demonstrate it.

We are obliged to defer all account of observations upon native Orchids of other tribes, except *Cypripedium*, upon which we must hazard a few remarks. Mr. Darwin has been able to examine only a few tropical species, and those incompletely. The North American species and the allied one of Northern Europe would probably have modified his conclusions. In none of our species is the pollen "so glutinous that it can be drawn out into threads."

In *C. acaule* it is granular, pulverulent, and almost dry, except the surface (laid bare by the sphacelation or deliquescence of the whole anterior face of the anther), which is as if freshly coated with sticky varnish, and so adhesive that a body of small surface brought in contact with it will bring away a piece of pollen of corresponding size; one of larger surface, like the tip of the finger or the head of a fly, brings away the whole mass of pollen of one or both cells. In the wild plants we find that the pollen is often carried off, either bodily or piece-meal. The stigma is rather concave than convex, and is slightly viscid.

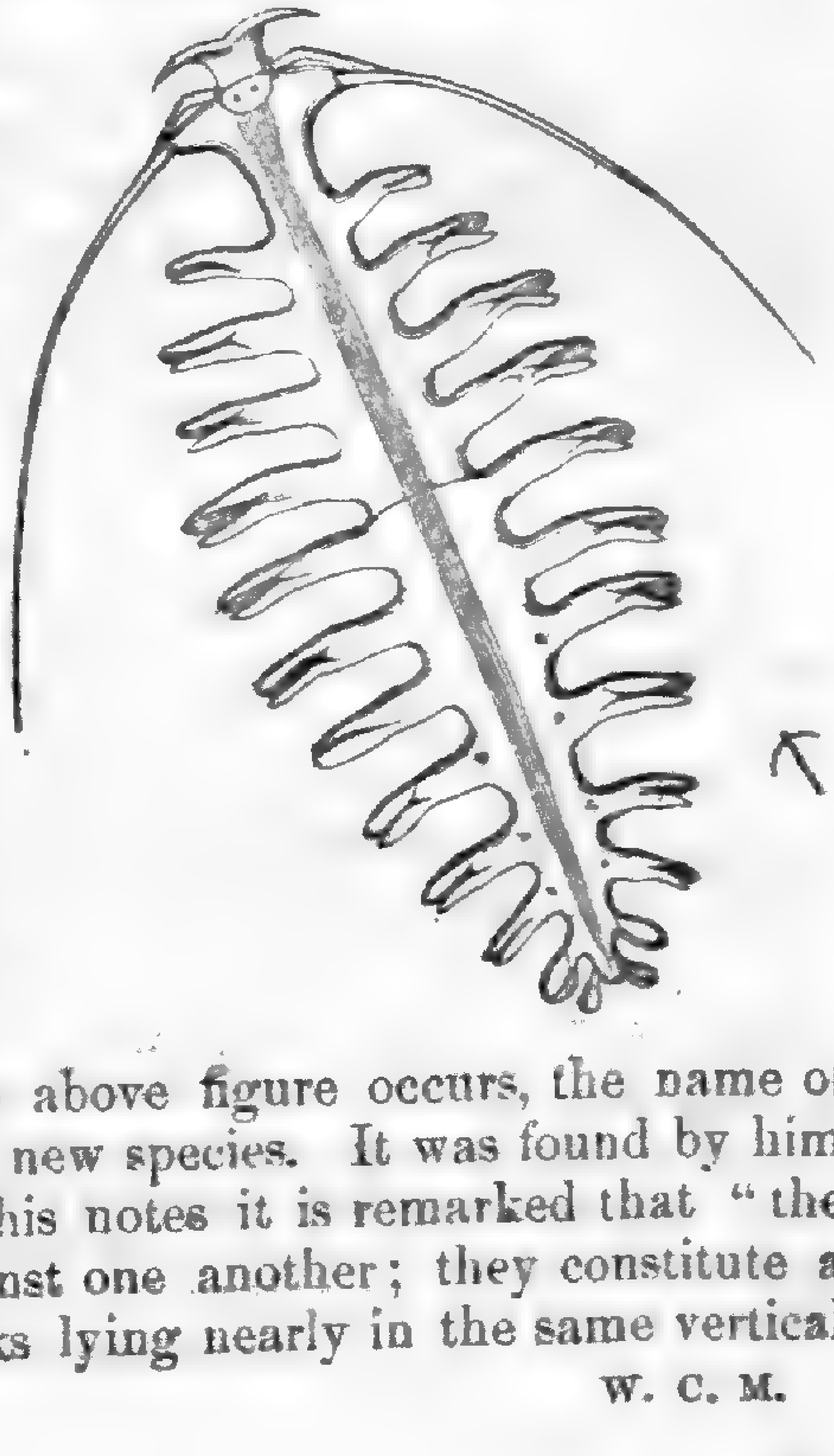
In *C. pubescens, parviflorum* and *spectabile*, the whole pollen (equally exposed by the destruction of the face of the anther after dehiscence) is pulpy but very little glutinous.

In all the species it is impossible that fertilization should be effected without extraneous aid. That aid may perhaps be given in the manner that Mr. Darwin supposes (but hardly in *C. spectabile*), that is, by a large insect inserting its proboscis into either of the lateral entrances at the base of the labellum, under the anther, and so thrusting some of the pollen forwards to the stigma, or more likely carrying some away to another flower, and leaving it on its stigma while attempting to gather the slight glutinous exudation that moistens the beard of long hairs which line the labellum underneath. But an attentive consideration of the arrangement in the species above mentioned, convinces us that the work is done by insects, such as flies, which crawl bodily into the flower. They may enter by one lateral opening, and so take a load of pollen upon the back of the head as they pass under the anther, which they would rub against the stigma, since they must crawl directly under it to feed on the nectar of the beard close underneath; and, escaping by the opening under the other anther, they would carry off some of its pollen to the flower of the next plant visited. But, although we have not been able to detect insects actually at work, we confidently gather from their traces, and from a variety of facts which we cannot here enumerate, that they ordinarily go in by the front entrance (even in *C. acaule*), crawl under the ample face of the stigma as they feed, where they cannot well avoid rubbing their heads or backs against the stigma, and passing on, make their exit by one of the lateral openings which now become visible to them, almost inevitably carrying off pollen on their head or shoulders as they escape, which pollen they would convey to the stigma of the next flower. Now the stigma offers no slight confirmation of this hypothesis, in a structure which has never before been noticed, but which is very striking in *C. spectabile*, &c., and most admirably adapted to the end in view. That is, the broad stigma, instead of being smeared with glutinous matter, as in ordinary Orchids, is closely beset with minute, rigid, sharp-pointed papillæ, all directed forwards,—so that the surface, when magnified, is like that of a wool-card of the olden time; and any pollen which an insect, working its way upwards to the base of the labellum, carries upon its head or back (to which alone it could be expected to adhere) would be neatly *carded* off by and left upon the stigma. The beauty of these adaptations can be appreciated only by actual inspection of the parts or of a series of figures.

We cannot close without an expression of gratitude to Mr. Darwin for having brought back teleological considerations into botany. So difficult is the study of functions in plants, so impossible often to find out the use or meaning of the various modifications of organs, and so unscientific and foolish the conjectures which are apt to be hazarded upon the subject, that Geoffroy's saying, 'science knows nothing of intention in nature' had well nigh become a conceded, even if unexpressed principle in natural history, especially in botany. Under the study of homologies—so fertile in excellent results—botany and even zoology have become almost exclusively morphological. In this fascinating book on the fertilization of Orchids, and in his paper explaining the meaning of dimorphism in hermaphrodite flowers, Mr. Darwin,—who does not pretend to be a botanist—has given new eyes to botanists, and inaugurated a new era in the science. Hereafter teleology must go hand in hand with morphology, functions must be studied as well as forms, and useful ends presumed, whether ascertained or not, in every permanent modification of every organ. In all this we *faithfully* believe that both natural science and natural theology will richly gain, and equally gain, whether we view each varied form as original, or whether we come to conclude, with Mr. Darwin, that they are derived;—the grand and most important inference of *design in nature* being drawn from the same data, subject to similar difficulties, and enforced by nearly the same considerations, in the one case as in the other. A. G.

ZOOLOGY—

3. *Upon a new species of Tomopteris.*—This minute worm, of which a magnified figure (made by Prof. Dana while in the East Indies) is here given, agrees in generic characters, (as they are stated by Grube, in *Die Familien der Anneliden,*) with *T. onisciformis*, from the figure of which however, (published by Quoy and Gaimard, in the *Ann. des Sci.*, 1re Sér., T. x,) it differs very markedly. It will be seen that, in the want of a tail, it corresponds to what Carpenter and Claparède—as reported by Dr. Leuckart, *Wiegm. Arch.*, 1860–61—have regarded as the young condition of *T. onisciformis;* but the minute size of the specimen, in connection with the absence of the anterior pair of bristles, which are also reported to characterize the young, make it highly improbable that we have here an immature form. Prof. Dana having very kindly placed at the disposal of the writer his occasional observations upon the Annelids made during the Wilkes Exploring expedition, among which the above figure occurs, the name of *Tomopteris Danæ* is proposed for this new species. It was found by him in the Sooloo sea in Jan., 1842. In his notes it is remarked that "the fingers of each arm do not fold against one another; they constitute a forked extremity to the arm, the forks lying nearly in the same vertical plane and diverging about 60°." W. C. M.



November 3, 1862.

III. ASTRONOMY AND METEOROLOGY.

1. *Name of Asteroid* (56).—In vol. xxxii, p. 438, was given an account of the re-discovery of asteroid (56) to which the name of Pseudo-Daphne had been provisionally given. M. Schubert has since selected for this planet the name of Melete, daughter of Uranus. The following corrected elements of Melete have been furnished by R. Luther.

Epoch 1861, Oct. 24, 0^h, m. t. Berlin.

Mean longitude at epoch,	323° 22′ 52″·49
Longitude of perihelion,	293 39 30 ·00
Longitude of ascending node,	194 24 17 ·03
Inclination of orbit,	8 1 49 ·05
Excentricity,	0·2368702
Mean daily motion,	847″·49126
Mean distance,	0·2597651

When in opposition and at its mean distance, this planet is equal to a star of the 12th magnitude.

2. *The Asteroids Feronia and Niobe.*—The asteroid Feronia, at first numbered (72), having been discovered before Niobe, the numbers have been changed accordingly, and Feronia is now designated by the number (71), while Niobe is designated by the number (72).

3. *Name of Asteroid* (73).—In vol. xxxiii, p. 436, was announced the discovery of asteroid (73). To this planet has been given the name of Clytia. The following elements were computed by T. H. Safford.

Epoch 1862, May 2d, 0^h, m. t. Washington.

Mean longitude at epoch,	184° 30′ 53″·6
Longitude of perihelion,	61 11 13 ·5
Longitude of ascending node,	7 32 23 ·7
Inclination,	2 24 49 ·6
Excentricity,	0·0439797
Mean daily motion,	815″·029
Mean distance,	·2666177

4. *Discovery of Asteroid* (74).—This planet was discovered by Henry M. Parkhurst of New York, Sept. 25, 1862. The following observations have been furnished by Mr. Parkhurst.

Washington m. t.		App. R. A.	App. Dec.
Sept. 25,	7^h 46^m	23^h 46^m 36^s	+1° 5′
26,	7 42	45 59	0 58
27,	8 17	45 17	0 51
29,	8 9	43 56	0 36

The brightness of this planet is equal to that of a star of the eleventh magnitude.

5. *Discovery of Comet* I, 1862.—On the 2d of July, M. Tempel at Marseilles discovered near β Cassiopeiæ, a comet which had the brightness of a star of the 4th or 5th magnitude. On the same evening the comet was discovered at Athens by M. Schmidt. Its apparent diameter was from 20′ to 25′. On the 3d of July, the same comet was discovered also by Prof. Bond at the Cambridge Observatory. Between the 3d and 4th its daily motion, reduced to the arc of a great circle, was 24°, indicating a close proximity to the earth. Its distance from the earth on the

4th of July was by computation only nine millions of miles. The following elements have been computed from observations of July 3, 13, and 23d.

$$\begin{aligned} T &= 1862,\ \text{June } 22{\cdot}06776 \text{ Berlin.} \\ \pi &= 299^\circ\ 20'\ 27''{\cdot}0 \\ \Omega &= 326\ \ 32\ \ 53\ {\cdot}5 \\ i &= 7\ \ 54\ \ 26\ {\cdot}1 \\ \log.\ q &= 9{\cdot}991818 \end{aligned}$$

Motion retrograde.

6. *Comet II*, 1862.—The discovery of this comet, July 18th, at the Dudley Observatory, was mentioned in the last number of this Journal, p. 294. On the same evening this comet was discovered at the Cambridge Observatory by H. P. Tuttle. On the 22d of July it was discovered at Florence; on the 25th it was discovered at Rome; and on the 26th it was discovered independently at Copenhagen.

The following elements have been computed from observations of July 24, 31, and Aug. 6th.

$$\begin{aligned} T &= 1862,\ \text{Aug. } 23{\cdot}08967. \quad \text{m. t. Milan.} \\ \pi &= 344^\circ\ 33'\ 28''{\cdot}7 \\ \Omega &= 137\ \ 12\ \ 15\ {\cdot}2 \\ i &= 66\ \ 12\ \ 50\ {\cdot}4 \\ \log.\ q &= 9{\cdot}983886 \end{aligned}$$

Motion retrograde.

On the 15th of August this comet attained a north declination of 82°, and for five weeks from its first discovery, it remained within the circle of perpetual apparition. It was nearest to the earth on the 31st of August, when its distance was thirty-three millions of miles; and it would have appeared to great advantage had it not been for the light of the moon, then at the first quarter.

7. *Minima of Algol.*—The following are the computed dates of minimum brightness of Algol for November and December, 1862, expressed in Greenwich mean time.

Nov.	2.	$18^h\ 36^m$	Nov.	25.	$17^h\ \ 7^m$	Dec.	18.	$15^h\ 38^m$*
	5.	15 25*		28.	13 56*		21.	12 27*
	8.	12 14*	Dec.	1.	10 45		24.	9 16
	11.	9 3		4.	7 34		27.	6 4
	14.	5 51		7.	4 22			

The dates marked with an asterisk will be convenient for observation in this country, and it is hoped they will not entirely escape the attention of observers.

8. *Maximum of Omicron Ceti.*—The brightness of Omicron Ceti was carefully observed during the past summer by M. Schmidt, at Athens, and the time of its maximum fixed at July 2d. It was then slightly fainter than Alpha Ceti. As the period of this star is 332 days, the next maximum will occur May 30, 1863, which probably however cannot be observed on account of proximity to the sun.

METEOROLOGY.

9. *Detonating Meteoric fireball of Dec. 3d*, 1861.—Prof. E. Heis publishes in his "*Wochenscrift für Astronomie, &c.*" a detailed account of a bright meteoric ball which exploded with a loud detonation a few miles N.E. of Halle, about 7 o'clock, P. M., Dec. 3d, 1861. It was seen through-

out Germany, even as far as Vienna, 300 miles distant. He received about forty accounts of its appearance, some of them from persons accustomed to observations upon fireballs and shooting stars. The places of the observers were such as to give excellent data for computing the meteor's path. Few of these bodies have been better observed.

Prof. Heis concludes that it first appeared at an altitude of 130 English statute miles over N. lat. 52° 30′, E. long. 11° 55′, that is, a few miles N.E. of Magdeburg. It exploded, breaking into two or three parts, at an altitude of 57 miles, over N. lat. 51° 38′, E. long. 12° 10′. The length of path was 88 miles, and the course sharply downwards, making an angle of about 50° with the horizon. It moved about 10° east of south.

The interval of flight was variously estimated, but most of the observers called it from three to five seconds. Four seconds gives a relative velocity of 22 miles. The diameter of the meteor he estimated at more than 900 feet.

Its brilliancy, at the distance of 140 miles, equalled that of the full moon. At Vienna it was at first equal to Venus, but increased to three times the brilliancy of that planet. At Berlin, 100 miles distant, the light was considered equal to that of a gaslight. Prof. Heis hence estimates its intrinsic light as 68,000,000 times that of an ordinary gas flame.

The first altitude of this body is probably greater than that of any *large* fireball whose path has been determined with tolerable accuracy.

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *The Thirty-second Meeting of the British Association for the Advancement of Science.*—The British Association met this year at Cambridge, on the 1st of October and adjourned after a week's session. This thirty-second meeting appears to have been less interesting and by far less numerously attended than most of the former sessions of this body. The address of the President, Prof. Willis, is given in full by the London Athenæum of Oct. 4, but is too long to transfer to our pages, especially as its contents are not particularly interesting to American readers. We copy the following abstract of Prof. Willis's address from the Chemical News of Oct. 11:—

This address was devoted to a statement of the objects of the Association, a history of its proceedings, and a detailed account of the various grants of money made by it, for the advancement of science, during the thirty years of its existence. The last, it seems, have amounted to 20,000*l*. Two thirds, or twelve parts of this sum, it appeared, had been expended on the sections of mathematics and physics; geology and mechanical science had received two parts each; and one part had been given to botany and zoology. It further appeared that very little had been devoted to the advancement of chemistry, only one-eighteenth having been divided among the sections of chemistry, geography, and statistics; and we believe it may be added with truth, that but a very small proportion of this eighteenth has been allotted to the first of these sciences. The large share assigned to the first section, the President said, was sufficiently accounted for by the nature of the subjects included in it, which require innumerable and expensive instruments of research, observations, and expeditions to all parts of the globe. The principal items of expenditure mentioned were for catalogues of the stars, the maintenance of Kew Observatory, observations to determine the course of the tide wave in various parts of the world, and for the construction of instruments, and a series of observations and surveys in connection with meteorology and terrestrial magnetism. 2600*l.* have been expended on geology; 1600*l.* of which were employed in the completion of the fossil ichthyology of Agassiz, and Owen's reports on fossil mammalia and reptiles; and 900*l.* had been paid for experiments conducted by Mr. Scott Russell on the forms of vessels. The results of these valuable experiments were ready for press in 1844, but the great expense of printing them has hitherto prevented their publication, which is no doubt to be regretted. 900*l.* have been expended on zoological researches in different districts and countries; much of it on dredging committees for obtaining specimens of the marine zoology of our own coasts. 200*l.* have been disbursed by a committee formed in 1840 to make experiments on the preservation of the vegetative power in seeds, which have resulted in the discovery, that the greatest age at which seeds were found to vegetate was about forty years.

As is usual on these occasions, the President, in his address, passed in review the principal scientific events of the year, chemistry being referred to as follows:—"In chemistry the greatest advance which has been made during the past year is probably the formation of compounds of carbon and hydrogen by the direct union of those elements. M. Berthelot has succeeded in producing some of the simpler compounds of carbon and hydrogen by the action of carbon intensely heated by electricity or hydrogen gas; and from the simpler compounds thus formed he is able to produce, by a succession of steps, compounds more and more complex, until he bids fair to produce from inorganic sources all the compounds of carbon and hydrogen which have hitherto been only known as products of organic origin. Mr. Maxwell Simpson has also added to his former researches a step in the same direction, producing some organic products by a synthetical process. But these important researches will be fully laid before you in the lecture on Organic Chemistry which Dr. Odling has kindly promised for Monday evening next. Dr. Hofmann has continued his indefatigable researches on Poly-ammonias, as well as on the coloring matters produced from coal tar. Mr. Schlœsing proposes a mode of preparing chlorine by a continuous process, which may, perhaps, become important in a manufacturing point of view. In this process nitric acid is made to play the same kind of part that it does in the manufacture of sulphuric acid, the oxyds of nitrogen acting together with oxyds of manganese as carriers of oxygen from the atmosphere to the hydrochloric acid. The methods of dialysis announced last year by the Master of the Mint, (Prof. Graham) and of spectrum analysis, are now in everybody's hands, and have already produced many interesting results."

After a short notice of some public works, the learned President alluded to the lamented death of Prince Albert, and the loss of Professors Cummings and Henslow, who filled the chairs of Chemistry and Botany at Cambridge, and so concluded an address which was generally thought to be decidedly dry and somewhat dull.

In proposing a vote of thanks the Dean of Ely amused the audience by wishing Professor Willis life, happiness, and prosperity till he had completed his report on "Acoustics" (a work begun in 1832); and the learned Dean thought that all would agree with him, that he who desired the longest life could not desire a longer than he wished the Professor.

The various Sections commenced their sittings on Thursday morning. As has been the case at the two last meetings, the greatest interest seemed to be excited by the discussions in Section D, which bore on the Darwinian theory, most of the visitors, scientific and non-scientific, lay and clerical, male and female, appearing particularly anxious to learn the exact relationship (if any) which existed between a man and a monkey.—Section B, Chemical Science, had the usual select audience. It was presided over by Professor W. H. Miller, and the Secretaries were Dr. Odling, Professor Roscoe, and W. H. Elphinstone, M.A.

We add a few notices of some of the papers read before the various sections:—

A. PHYSICAL SECTION.—President, G. G. STOKES.—*On the extent of the Earth's Atmosphere*; by Prof. CHALLIS.—The object of this paper was to show that the earth's atmosphere is of limited extent, and reasons were adduced, in the absence of data for calculating the exact height, for concluding that it does not extend to the moon. It was argued on the hypothesis of the atomic constitution of bodies, that the upward resultant of the molecular forces on any atom, since it decreases as the height increases, must eventually become just equal to the force of gravity, and that beyond the height at which this equality is satisfied, there can be no more atoms, the atmosphere terminating with a small finite density. It has been generally stated that the earth's atmosphere is about 45 miles high, but on no definite grounds, and the estimates of the height have been very various. Against the opinion that it extends as far as the moon, it was argued, that, as the moon would in that case attach to itself a considerable portion by its gravitation, which would necessarily have some connection with the rest, there would be a continual *drag* on the portion more immediately surrounding the earth, and intermediately on the earth itself, which would in some degree retard the rotation on its axis. Hence, if, as there is reason to suppose, the rotation be strictly uniform, the earth's atmosphere cannot extend to the moon. The author also stated that if by balloon ascents the barometer and thermometer were observed at two heights ascertained by observation, one considerably above the other, and both above the region in which the currents from the equator influence the temperature, data would be furnished by which an approximate determination of the height of the atmosphere might be attempted.

On the Augmentation of the Apparent Diameter of a body by its Atmospheric Refraction; by the Rev. Prof. CHALLIS.—For reasons given in the preceding communication, it was assumed that atmospheres generally have definite boundaries at which their densities have small but finite values. Two cases of refraction were considered: in the one, the curvature of the course of a ray through the atmosphere was assumed to be always less than that of the globe it surrounds; and in the other, the curvature of the globe might be the greater. The former is known to be the case of the earth's atmosphere; and it was supposed that, *à fortiori*, this must be the case with respect to any atmosphere the moon may be supposed to have. On this supposition it was shown that the apparent diameter of the moon, as ascertained by measurement, would be greater than that inferred from the observation of an occultation of a star, because, by reason of the refraction of the atmosphere, the star would disappear and reappear when the line of vision was within the moon's apparent boundary. The same result would be obtained from a solar eclipse. It was stated that, by actual comparisons of the two kinds of determinations, such an excess to the amount of from 6″ to 8″ was found. This difference may reasonably be attributed to the existence of a lunar atmosphere of very small magnitude and density. The author also stated that from this result there would be reason to expect, in a solar eclipse, that a slender band of the sun's disk immediately contiguous to the moon's border would be somewhat brighter than the other parts, and advised that especial attention should be directed to this point on the next occurrence of a solar eclipse. The case in which the curvature of the path of the ray is greater than that of the globe was assumed to be that of the sun's atmosphere; and it was shown, on this supposition, that all objects seen by rays which come from the sun's periphery are brought by the refraction to the level of the boundary of the atmosphere, whether they proceeded from objects on the surface of the interior globe, or from clouds supposed to be suspended in the atmosphere. Accordingly, the contour of the sun should appear quite continuous, and the augmentation of apparent semi-diameter will be equal to the angle subtended at the earth by the whole height of the atmosphere. The apparent diameters of the planets will, for like reasons, be augmented to a certain amount by the effect of refraction; and on account of the great distances of these bodies from the earth, the eclipse of a satellite will take place, as soon as the visual ray is bent by the interposition of the atmosphere.

Provisional Report on Thermo-electric Currents in Circuits of one Metal; by Mr. F. Jenkin.—Mr. Jenkin first gave a short description of the electrical currents to which he had drawn the attention of the Association at their previous meeting, as due to loose contacts between two unequally heated wires of one metal. Experiments were then described with loose contacts between wires of two dissimilar metals. The great intensity of the currents so obtained, compared with the ordinary thermo-electric currents from metallic contact between the two metals was pointed out; and it was shown that an analysis of the results proved, beyond doubt, that the currents were of the same nature as those produced by unequally-heated metals placed in an electrolyte: the thin films of melted oxyds of copper and iron constitute this electrolyte with unequally-heated junctions at surface of the two wires. This theory requires that the oxyd of copper should be considered far more positive than iron, and the oxyd of iron far more negative than copper. Direct experiments with oxyds of iron and copper between platinum wires confirmed this conclusion. It was, however, still considered doubtful how far electrolytes could be included in a true thermo-electric scale. It was stated that Sangoni had, in 1853, anticipated some of these results. A suggestion was then made that the current observed by Magnus and others at the first metallic contact of unequally-heated wires of one metal may be due to the fact that the electrical qualities of a perfectly homogeneous metal do not depend solely on its temper and temperature, as has been hitherto supposed, but to some extent on the time during which it has been maintained at that temperature; a fact proved, as regards electrical resistance by Mr. Mathiessen. In support of this view, it was stated that the currents obtained from these metallic contacts are not instantaneous, as generally supposed, but continue for, at least, five minutes after contact has been made, gradually diminishing from a maximum to a zero.

On the Zodiacal Light and Shooting Stars; by Prof. Challis.—The phenomena of the zodiacal light, as gathered from observations made both in northern and in southern latitudes, were stated to be as follows:—As seen in north latitudes, it appears in the west after the departure of twilight, as a very faint light, stretching along the ecliptic, about 10°

broad at its base in the horizon, and coming to an apex at an altitude of 40° to 50°. It is most perceptible in the west in the months of February and March, at which time its apex is near the Pleiades. Similar appearances are presented in the morning before sunrise in the east, in the months of August and September. The light seen in the autumn lies in the *same* direction from the sun as that seen in the spring. In the southern hemisphere, the appearances are strictly analogous; but the times and positions of maximum visibility are the evenings in autumn in the west and the mornings in spring in the east. The portion best seen in the southern hemisphere lies in the *opposite* direction from the sun to that which is best seen in the northern hemisphere. The portion seen and the degree of visibility depend on the inclination to the horizon of the part of the ecliptic along which the light stretches. The greater the inclination, the better it is seen. At the December solstice, opposite portions have been seen in the northern hemisphere, one in the morning and the other in the evening; and in the southern hemisphere opposite portions have been similarly seen at the June solstice. At these seasons, the ecliptic is inclined at large and equal angles to the horizon, at equal intervals before sunrise and after sunset.

On Autographs of the Sun; by Prof. Selwyn.—Prof. Selwyn showed several "autographs of the sun," taken with his "heliautograph," by Mr. Titterton, photographer, Ely, which consists of a camera and instantaneous slide, by Dallmeyer, attached to a refractor of $2\frac{3}{4}$ inches aperture, by Dolland; the principle being the same as that of the instrument made, at the suggestion of Sir J. Herschell, for the Kew Observatory; and the Professor expressed his thanks to Mr. Balfour Stewart and Mr. Buckley for their advice. The autographs are of July 25, 26, 28, 29, 31; August 1, 2, and August 4, 10, 15 A. M. and 11.30 A. M. (a series of bright days coincident with a large group of spots); August 19, 20, 23, and 25, where the same group reappears much diminished; September 19, 23, 26 and 30, in which is seen a group of spots 118,000 miles in length. On the 23d three autographs are taken, two of them with the edge of the sun in the centre of the photographic plate, showing that the diminution of light towards the edges of the disc is a real phenomenon, and not wholly due to the camera. In the two of the 4th of August, where the great spot (20,000 miles in diameter) appears on the edge, a very distinct *notch* is seen, and the sun appears to give strong evidence that the spots are cavities; but eye observations and measurements by the Rev. F. Howlett, and others, tend to show that this evidence is not conclusive, for there was still a remaining portion of photosphere between the spot and the edge. The phenomena shown in these autographs appear to confirm the views of Sir J. Herschell, that the two parallel regions of the sun where the spots appear, are like the tropical regions of the earth, where tornadoes and cyclones occur, and those of Wilson in the last century. The *faculæ* seem to show that the tropical regions of the sun are highly agitated, and that immense waves of luminous matter are thrown up, between which appear the dark cavities of the spots, whose sloping sides are seen in the penumbræ, as explained by Wilson and others. Other analogies between solar spots and earthly storms were pointed out, and reference was made to the glimpses of the structure of the sun exhibited by Mr. Nasmyth as confirming the above views.

Some Peculiar Features in the Structure of the Sun's Surface; by JAMES NASMYTH.—The author said the subject was in itself most interesting, but had been rendered much more so by the researches of Bunsen and others upon the solar spectrum. He himself had paid much attention to the structure of the sun and moon, but lately more particularly to that of the sun. He had been fortunate enough to secure some exceedingly perfect instruments, and a very favorable condition of the atmosphere. His first observation of the phenomena he was about to describe was made on July 20, 1860. It is still a mooted point as to what the spots on the sun really are, but it is generally supposed that they are openings on the luminous surface. When observing these appearances he noticed that the outer luminiferous envelope of the sun was composed of lenticular or willow-shaped filaments, and it is from these that the whole of the solar light emanates. Next to this comes the penumbra, then a misty envelope, and lastly the body of the sun itself, which is dark, dense, and not a light-giving substance. The willow-shaped filaments mentioned are not distributed in symmetrical order, but in a heterogeneous mass. This accounts for the mottled appearance of the sun, seen by the most common observer through a telescope. He would offer no hypothesis as to what the composition or the functions of this luminiferous envelope might be, but thought it had better remain till a great number of facts had been collected. His sole object was to introduce to the notice of scientific men the facts he himself had collected.

Mr. Nasmyth, in answer to some questions put to him, stated that he had used Sir John Herschel's eye-glass, of which he detailed the construction. The size of the willow-shaped filaments he should imagine, at a rough guess, to be 1000 miles long by 90 broad. The most suitable magnifying power for observing this phenomena is 200; for, as the air is seldom tranquil with a higher magnifying power, it is difficult to retain distinctness. The luminous tracts composing the outer envelopes seem to be in motion among themselves, moving with enormous velocity; and when a spot upon the surface of the sun ceases to be so any longer, they come sailing across to fill up the space, like (said Mr. Nasmyth) a shoal of herrings.

B. CHEMICAL SECTION.—President, W. H. MILLER.—*On the Luminosity of Phosphorus;* by Dr. MOFFAT.—If a piece of phosphorus be put under a bell-glass and observed from time to time, it will be found at times luminous, and at others non-luminous. When it is luminous, a stream of vapor rises from it, which sometimes terminates in an inverted cone of rings similar to those given off by phosphoretted hydrogen; and at others it forms a beautiful curve, with a descending tint equal in length to the ascending one. The vapor is attracted by a magnet; it is also attracted by heat, but it is repelled by cold. It renders steel needles magnetic, and it is perceived only when the phosphorus is luminous. Results deduced from daily observations of the phosphorus in connection with the readings of the barometer, the temperature and degree of humidity of the air, with directions of the wind, for a period of eighteen months, show that periods of luminosity of phosphorus and non-luminosity occur under opposite conditions of the atmosphere; the former being peculiar to the equatorial, while the latter is peculiar to the polar current. By the catalytic action of phosphorus on atmospheric air, a gaseous body (superoxyd of hydrogen) is formed, which is analogous to if not the same as atmospheric ozone, and it can be detected by the same tests. The author has found, by his usual tests, that *phosphoric* ozone is developed only when the phosphorus is luminous. Periods of luminosity and periods of atmospheric ozone take place under similar atmospheric conditions, and the conditions of non-luminous periods and periods of non-atmospheric ozone are the same. From the author's observations in connection with this matter, which extend over several years, it appears that 99 per cent of luminous periods and 91 per cent. of ozone periods commence with decreasing readings of the barometer and other conditions of the equatoreal current; and that 94 per cent and 66 per cent terminate with increasing readings and the conditions of the polar current. Luminous periods commence and luminosity increases in brilliancy on the approach of storms and gales, and ozone periods commence and luminosity increases in quantity under similar conditions. There is, it would appear also from these observations, an intimate connection between the approach of storms, the commencement of luminous and ozone periods and disorders of the nervous, muscular and vascular systems. Here the author gave the dates of many storms and gales, and the occurrence of diseases of the above class, showing their coincidence; and in corroboration of what he had stated, he mentioned the fact that there was a concurrence in the issuing of Admiral FitzRoy's cautionary telegrams and these diseases. He also stated that he views the part performed by ozone in the atmosphere as being similar to that performed by protein in the blood; the latter giving oxygen for the disorganization of worn-out tissues in the animal economy,—the former giving oxygen to the products of decomposition and putrefaction, and rendering them innocuous or salutary compounds. With these views he has used phosphorus as a disinfectant; and from the results he has obtained, he believes that by using ozone artificially formed by the action of phosphorus in localities tainted with the products of putrefaction, just in sufficient quantity to tinge the usual test-paper, all diseases of the pythogenic class would be prevented. Although the data are too few to theorize upon, Dr. Moffat hoped that he would be excused for pushing the matter beyond a simple statement of facts and observations, as many facts had been observed in nature which strongly corroborated all he had advanced. Ozone, he observed, is in all probability formed wherever there is phosphorescence; and this is by no means an uncommon phenomenon. It is seen in life and in death, in the animal and vegetable kingdoms, and in the mineral kingdom. Here many instances of phosphorescent bodies were enumerated, among which the night-shining Neries was named as becoming particularly brilliant with a direction of wind from points of the compass between east and south; and the fact that the sea becomes luminous on the approach of storms by marine animals floating on its surface was noticed. Many phosphorescent minerals were named; the fluor spar being particularly pointed out as being not only phosphorescent on slight increase of temperature, but as giving off ozone. The author concluded by observing that it is not improbable that atmospheric ozone is formed by the phosphorescence of these and similar bodies, and pointed to the absence of ozone and weak magnetic action during cholera periods, which are periods of non-luminosity, and to the disappearance of cholera with the setting in of the equatorial current, which is ozoniferous and favorable to luminosity. The aurora, the author thinks, may yet be proved to be a display of luminosity.

C. Geology.—President, J. B. Jukes.—The President inquired how the variations of the surface called mountains, hills, cliffs, glens, valleys and plains were formed. He took, first, the formation of great plains, and showed that although some were formed as plains on horizontal beds, few even of these retained the original surface of deposition, but had more or less a denuded surface. Many equally level plains were low and level, because mountainous masses of rock, often greatly disturbed and contorted, had been removed from above the present surface. The central plain of Ireland, and other plains in the British Islands, were formed in this way. All mountains, except volcanoes or "hills of ejection," were either "hills of circumdenudation," formed by the wearing down and removal of the rocks formerly around them, or "hills of uptilting." In the latter, the lowest rocks appeared in the central parts of the chain, often reared into the highest peaks; and these central beds dip on either hand under higher and higher groups, which come in as we recede from the axis of the chain. The beds have been raised by mechanical force acting from below; but this, however it had tilted or bent them, could not remove them, so that the successive exposure of lower and lower beds as we approach the axis of the chain must be owing to the external erosion of moving water. These "hills of uptilting," then, were hills not in consequence, but in spite of denudation, and would have been many times loftier had it not been for the erosive action. Mr. Jukes declared his belief that all the striking external features were the result of the direct action of the external forces called the "weather," and were not caused by any direct action of the internal forces, which could only reach the surface through the thickness of the crust. He then examined these forces of erosion; and while he attributed to marine action all the greater and more general features, the great plains, the long escarpments, and the general outline of the mountains, he believed that the valleys which traversed the plains, the gullies that furrowed the sides of the hills, and the glens and ravines on the flanks of the mountains, were all due to the action of the ice or water which fell on them from the atmosphere. He did not give these views as altogether original, but mentioned Mr. Charpentier and Mr. Dana as having long ago applied them to the Pyrenees and to the Blue Mountains of New South Wales; but, having been long sceptical as to their reality, he now wished to record his conviction of their truth. Mr. Prestwich, Prof. Ramsay and himself, while pursuing different lines of investigation, had all been simultaneously compelled to appeal to the sub-aërial action as the only method of explaining the phenomena they had met with; and Dr. Tyndal had since fallen into the same line of march.

On the last eruption of Vesuvius; by Dr. Daubeny.—The author confines himself to those phenomena which appeared to present some novelty, and to have a bearing upon the general theory of volcanic action. Vesuvius appears during the last few years to have entered upon a new phase of action. Its eruptions are more frequent but less violent than they were formerly; they proceed from a lower level than they did at an earlier period; and they give vent to certain new volatile or gaseous principles, such as the vapor of naphtha and and light carburetted hydrogen, or marsh gas, never before detected. The last eruption has likewise caused an elevation of the coast to the height of 3 feet 7 inches above the level of the sea, which has not been observed on any preceding occasion. In speculating upon the causes which have produced these changes in the nature of the operations of Vesuvius, the author first considers the theory which recognizes a second class of volcanoes distinct from those ordinarily known as such, and designated by the name of mud volcanoes. As these are characterized by the emissions of carburetted hydrogen and naphtha, as well as of semi-fluid mud, it might be suggested by those who regard them as partakers of the nature of volcanoes, that Vesuvius was now passing into the condition of a mud volcano from its emitting these same products. But the author finds reason for denying that the so-called mud volcanoes, of which Macalube in Sicily and Taman in the sea of Azof are types, have anything in common with genuine volcanoes, such as Vesuvius, and he therefore contends that the above products are generated simply owing to the action of volcanic heat upon contiguous beds of Apennine limestone containing bituminous matters imbedded. Hence would arise the enormous evolution of carbonic acid observed, and the carburetted hydrogens as well as naphtha vapor which are found to accompany it, and which may be regarded as the secondary and incidental products of volcanic action, whilst the muriatic and sulphurous acids are primary and effectual ones. The auther concluded by recommending to the explorers of volcanic phenomena the accurate examination of the gases evolved, as the best clue to the explanation of the true nature and cause of volcanic action. The latest remarks of Deville and others on volcanic emanations present nothing irreconcilable with the chemical theory of volcanoes which the author has so long espoused; but all he asks of geologists is, diligently to record the facts, chemical as well as physical, which volcanoes present, instead of contenting themselves with simply referring the eruptions to certain great cosmical changes which they imagine to be taking place.

D. Zoology.—President, Prof. Huxley.—*On the Zoological Significance of the Brain and Limb characters of Man, with Remarks on the Cast of the Brain of the Gorilla;* by Prof. Owen.—Prof. Owen exhibited two casts, one of the human brain, which had been hardened in spirits, and had therefore not preserved its exact form, but to all intents and purposes it would serve as an illustration of the human brain. The other cast was taken from the interior of the cranium of the gorilla. From an examination of these, the difference between the brain of man and that of monkeys was at once perceptible. In the brain of man, the posterior lobes of the cerebrum overlapped, to a considerable extent, the small brain, or cerebellum; whereas, in the gorilla, the posterior lobes of the cerebrum did not project beyond the lobes of the cerebellum. The posterior lobes in the one were prominent and well marked; in the other, deficient. These peculiarities had been referred to by Todd and Bowman. From a very prolonged investigation into the characters of animals, he felt persuaded that the characters of the brain were the most steadfast; and he was thus induced, after many years of study, to propose his classification of the mammalia, based upon the differences in the development of their brain structure. He had placed man—owing to the prominence of the posterior lobes of his brain, the existence of a posterior cornu in the lateral ventricles, and the presence of a hippocampus minor in the posterior cornu,—in a distinct sub-kingdom, which he had called Archencephala, between which and the other members of the mammalia the distinctions were very marked, and the rise was a very abrupt one. The brain, in his estimation, was a far better guide in classifying animals than the foot; but the same difference that existed between their brains was also observable between their feet. The lecturer referred to a diagram which represented the feet of the aye-aye, the gorilla and man, pointing out the chief differences in the structure of the skeleton. These differences he considered sufficiently great to elevate man from the sub-kingdom to which the monkeys belonged, and to place him in a distinct sub-kingdom by himself.

Prof. Huxley observed that the paper just laid before the Section appeared to him in no way to represent the real nature of the problem under discussion. He would therefore put that problem in another way. The question was partly one of facts, and partly one of reasoning. The question of fact was, what are the structural differences between man and the highest apes?—the question of reasoning, what is the systematic value of those differences? Several years ago, Prof. Owen had made three distinct assertions respecting the differences which obtained between the brain of man and that of the highest apes. He asserted that three structures were "peculiar to and characteristic" of man's brain—these being the "posterior lobe," the "posterior cornu," and the "hippocampus minor." In a controversy which had lasted for some years, Prof. Owen had not qualified these assertions, but had repeatedly reiterated them. He (Prof. Huxley), on the other hand, had controverted these statements; and affirmed, on the contrary, that the three structures mentioned not only exist, but are often better developed than in man, in all the higher apes. He (Prof. Huxley) now appealed to the anatomists present in the Section whether the universal voice of Continental and British anatomists had not entirely borne out his statements and refuted those of Prof. Owen. Prof. Huxley discussed the relations of the foot of man with those of the apes, and showed that the same argument could be based upon them as on the brain: that argument being, that the structural differences between man and the highest ape are of the same order and only slightly different in degree from those which separate the apes one from another. In conclusion, he expressed his opinion of the futility of discussions like the present. In his opinion, the differences between man and the lower animals are not to be expressed by his toes or his brain, but are moral and intellectual. Prof. Rolleston said he would try and supply the members of the Association with the points of positive difference between the human and the ape brain. For doing this we had been abundantly shown that the hippocampus minor and the posterior lobe were insufficient. As differentive, they must be given up at last. But as much had recently been done for the descriptive anatomy of the brain by Gratiolet and others as had been done for astronomy by Stokes and Adams, for language by Max Müller, and that this had been ignored in this discussion was little creditable to British science. This analysis of the brain's structure had established as differentive between man and the ape four great differences—two morphological, two quantitative. The two quantitative are the absolute weight and the great height of the human brain; the two morphological, the multifidity of the frontal lobes corresponding to the forehead, usually, popularly, and, as this analysis shows, correctly, taken as a fair exponent of man's intelligence, and the absence of the external perpendicular fissure. This had been abundantly shown by Gratiolet. No reference to these most important matters had been made by Prof. Owen; and this omission could not fail to put the British Association's repute for acquaintance with the works of foreign fellow-laborers at great disadvantage in the eyes of such foreigners as might be present.* Prof. Rolleston concluded by saying that if he had expressed himself with any unnecessary vehemence, he was sorry for it; but that he felt there were things less excusable than vehemence, and that the laws of ethics and love of truth were things higher and better than were the rules of etiquette or decorous reticence. Mr. W. H. Flower, looking at the subject solely in the anatomical view and as a question of fact, stated that the result of a considerable number of dissections of brains of various monkeys was that the distinction between the brain of man and monkeys did not lie in the posterior lobe or the hippocampus minor, which parts were proportionately more largely developed in many monkeys than in man, and that if these parts were used in the classification of man and the monkeys the series would be,—first, the little South American marmosets; then would follow the baboons, the cercopitheci, macaque; then man must be placed, followed by the anthropoid apes, the orang-outang, chimpanzee and gorilla; and last, the American howling monkey.—Prof. Owen replied, that Prof. Rolleston had led the meeting to conclude that he had not paid any attention to the convolutions of the brain of mammals, and that the investigation of this subject was the exclusive property of the German anatomists; whereas he might be permitted to state that almost at the very time that Leuret wrote his memoir on this subject, he had delivered a course of lectures on the convolutions of the brain, which, he regretted, had not been published, owing to the pressure of other labors; but the diagrams were still in existence, as his successor could testify, in the Museum of the Royal College of Surgeons.

2. *Correspondence of Sir Wm Reid and W. C. Redfield.*—John H. Redfield, of Philadelphia, son of the distinguished investigator of the law of Storms, has presented to the Library of Yale College, the original letters of Sir W. Reid to Mr. W. C. Redfield, and copies of the letters of the latter, to Sir William. The correspondence is arranged chronologically and is bound in three handsome folio volumes. In order that gentlemen devoted to meteorology may understand the character of this collection of letters, so important in the History of the science of Storms, we append a note of Mr. J. H. Redfield, introductory to the volumes.

"The correspondence contained in these volumes consists for the most part of the autograph letters of Sir William Reid to William C. Redfield of New York, together with copies of those written by the latter in reply.

Sir William Reid (then a Lieutenant Colonel in the Engineer Service of Great Britain) was appointed Governor of the Bermuda Islands at the close of

* For a statement of the present status of opinion on this subject, see p. 188 —Eds.

1838. In 1846 he was transferred to Barbadoes, having under his government all the British Windward Islands of the West Indies. In 1848 he resigned this post and returned to England, where he was soon after put in charge of the Engineer Department at Woolwich, and in 1850 was appointed Chairman of the Executive Committee for the Great Industrial Exhibition of 1851. After the close of the Exhibition the honor of knighthood was conferred upon him, and in the beginning of 1852 he was made Governor of Malta, where he remained till the close of 1857, when the health of Lady Reid had suffered so much from the debilitating climate that he was compelled to resign his post and return to England. These letters therefore cover the whole period of his active service as a civilian, and bear testimony to the active and untiring zeal which as a Colonial Governor he manifested for the permanent welfare of the people of his government. His efforts for the improvement of Agriculture and Education and for the promotion of Temperance were unremitting and were crowned with the most gratifying results and well earned for him the title of "*The Good Governor*"—applied to him in Dicken's Household Words.

To the man of science however, these letters also possess an interest of another kind. In 1831 Mr. Redfield had shown that the phenomena attending the gales of the Atlantic coast of the United States all unerringly testified that these storms were great whirlwinds moving from the tropical towards the polar regions in a determinate path. He followed up this induction by repeated investigations of subsequent storms which confirmed his earlier conclusions. He availed himself of these demonstrated laws of rotation and progression in the storm-winds, to point out to navigators the means of eluding the violence and shortening the duration of these gales. These earlier papers of Mr. Redfield fell under the notice of Col. Reid, while stationed at Barbadoes as an engineer officer, and were to him the first satisfactory solution of a problem which had long engaged his attention. From this time Col. Reid became an active laborer in the same field of investigation, and he opened the correspondence which follows—a correspondence which continued for nearly twenty years until terminated by the death of Mr. Redfield.

These letters are therefore in a peculiar manner illustrative of the history of the "development of the law of storms and variable winds," while they are equally illustrative of the mental activity as well as the simplicity and benevolence of character, which marked these two friends, and so long harmonious laborers in a common field—each longing for the personal acquaintance of the other, but destined to meet only in a brighter and nobler sphere.

A few letters from Lady Reid, with the replies thereto, are included in this collection. They are necessary to render the series complete, and are worthy of preservation not only from her terse, vivacious style, but because her communications sometimes shed a light upon Governor Reid's merits, which his own modesty would hardly reveal.

Mr. Redfield's letters have been copied from his own letter-book, and are therefore in most cases second copies, but they cannot differ materially from the originals. The copying of these letters, and the arrangement of this collection have been done by his eldest son, and the hours spent in this labor have been sweetened by the memories of a revered parent, to whose virtues those who best knew him can best testify.

New York, January, 1858."

3. *Supposed fall of meteoric iron at St. Louis, Mo.*—On the morning of July 9th, 1862, about 11 o'clock, "a strange sound was heard in the air over the houses on the south side of Chestnut, between Second and Third streets. At the same instant a noise resembling that of an explosion of a steam boiler startled the people in the vicinity, and this was immediately followed by a crash through one of the large windows of the office of

John Riggin, Real Estate Agent, on the North side of Chestnut street. A crowd of curious persons rushed to the spot, to find out something more of the unusual occurrence, when they were rewarded by the discovery that a piece of solid iron—or rather what appeared to be a mixture of iron and other substances—weighing about a quarter of a pound, had fallen from the upper regions. We learn that the piece of iron will be handed over to the Academy of Science."—*St. Louis newspaper.*

Dr. B. F. Shumard, to whom we are indebted for this information, adds: "The specimen has the appearance of meteoric iron, and when found, weighed 25·375 mm. gr, measured one inch and a half in length, about ten lines in width and a half an inch in thickness.

"It is stated to have come from a southwestwardly direction, passing over some houses on the south side of Chestnut street, betwen 2d and 3d streets, striking the window of the office of Mr. John Riggin, Real Estate broker on the north side of Chestnut street, shattering a large pane of glass a few inches above the ground floor and then bounding obliquely backwards several feet. Mr. Eugene Riggin was in the office at the time of the fall, three or four feet from the window, and immediately ran out and picked up the specimen. Mr. Riggin is regarded here by all who know him as a man of veracity. Several persons of respectability on the street also witnessed the fall, and all of them state that they distinctly heard a whizzing noise during the passage of the body through the air. These are the facts as I gathered them immediately after I heard of the fall. I confess that I was somewhat sceptical at first, but after ascertaining the above facts I became a believer. Dr. Litton subsequently made a qualitative analysis of a part of the specimen but could not find any nickel. So I am again in doubt."—*Letter from Dr. Shumard.*

VI. BOOK NOTICES.

1. *Dana's Manual of Geology.**—In our last number we announced the near completion of Prof. Dana's Geology. Before these lines are seen by our readers the book will be issued. Favored by an inspection of the advanced sheets we are able to give some notice of the scope and contents of the volume.

The first feature of the work which arrests attention is its thoroughly American character. We copy from the Preface what the author says on this point.

"Two reasons have led the author to give this Manual its American character: a desire to adapt it to the wants of American students, and a belief that, on account of a peculiar simplicity and unity, American Geological History affords the best basis for a text book of the science. North America stands alone in the ocean, a simple isolated specimen of a continent (even South America lying to the eastward of its meridians), and the laws of progress have been undisturbed by the conflicting movements of other lands. The author has, therefore, written out American Geology by itself, as a continuous history.

* Manual of Geology: treating of the principles of the science with special reference to American Geological History, for the use of Colleges, Academies, and Schools of Science. By James D. Dana, M.A., LL.D., Silliman Professor of Geology and Natural History in Yale College, &c., &c. Illustrated by a chart of the world and over one thousand figures, mostly from American sources. Philadelphia: published by Theodore Bliss & Co. London: Trübner & Co. 1863. Small 8vo, pp. 812.

Facts have, however, been added from other continents so far as was required to give completeness to the work and exhibit strongly the comprehensiveness of its principles."

It has long been a just source of complaint that the students of geology must seek in vain for any compact and well arranged view of the system of American Geology, and few but professional geologists have had the courage to wade through the voluminous mass of matter embraced in the official Reports of the various State Geologists; while still fewer have felt themselves able to reconcile the numerous discrepancies growing out of a want of unity in plan and nomenclature among the authors of these reports.

Prof. Dana, with that methodizing skill and philosophic power which is a prominent feature of his mind, has here for the first time produced in full detail what may be emphatically called the American System of Geology. The science is here taught from American examples, and while no important principle or class of phenomena is left unillustrated by the choicest European or cosmopolitan instances, the student is delighted by finding the keys of the subject in his own hands, the field of study and observation being within his own reach.

An immense impetus was given to the study of British Geology by the writings of Buckland, Sedgwick, Murchison, Lyell, Bakewell, Mantell, Hugh Miller, and others, not more from the vigor and beauty of their style as authors, than from the fact that the subject was brought home to British tourists by the local interest inseparable from the name and fame of familiar domestic scenes. Such a service has Prof. Dana rendered to American students and tourists in his present work. But we should do the author injustice if we left the impression that this was the most important feature of the work, interesting as this is to American students.

It is as the historian of the earth's progress through the successive stages of its development that the author has shown his original power. From this point of view the volume demands the attention of a wider audience than can be asked for any mere text-book or local manual. It marks an era in the history of geological literature, and as an Epic of the earth will be read with interest everywhere. Few geologists have seen more of the earth's surface than Prof. Dana, and his powers and opportunities as an original observer have been second only to his power of analysis of the true value of the labors of others. The same characteristics of accurate and exhaustive statement and lucid order, which have made Dana's Mineralogy an authority in all countries, will carry the Geology home to the tables of a yet larger constituency.

The spirit in which the book is written is well expressed in the concluding lines of the preface.

"Geology is rapidly taking its place as an introduction to the higher history of man. If the author has sought to exalt a favorite science, it has been with the desire that man—in whom geological history had its consummation, the prophesies of the successive ages their fulfillment—might better comprehend his own nobility and the true purpose of his existence."

The sources from which Prof. Dana has drawn his materials as well as the geologists to whom he is indebted for assistance, are thus acknowledged:

"In the preparation of the American part of the volume, the author has freely used the reports of the various geological surveys of the country, the memoirs published in the different scientific journals and transactions, and other works bearing on the subject. He has also drawn from his own Memoirs and Exploring Expedition Reports, especially on the subjects of Coral islands, —Volcanic islands,—the Formation of Valleys by the action of rivers,—the General Features of the Globe, and their origin,—American geological history,—and the Temperature of the Globe, as exhibited on the Physiographic Chart.

The illustrations of American Palæozoic life have been largely copied from the Reports of Professor Hall. A few of the Palæozoic figures, and many of later periods, are from original drawings made by Mr. F. B. Meek, to whose artistic skill and palæontological science the work is, throughout, greatly indebted. The drawings were nearly all made on the wood for engraving by Mr. Meek; and the palæontological pages have had the benefit of his revision. The name of the engraver, Lockwood Sanford, of New Haven, also deserves mention in this place.

In selecting figures of foreign fossils for the Manual, those used in Lyell's and other standard English works have, with few exceptions, been avoided, so that the student owning any of those volumes will have additional illustrations of the science. Many of the foreign figures are from the beautifully illustrated "Paléontologie et Géologie" of Alcide d'Orbigny.

The author would make acknowledgments to his countrymen for the readiness with which they have furnished aid, whenever appealed to, and especially, for oft-repeated favors. to J. P. Lesley, of Philadelphia; J. S. Newberry, of Cleveland, Ohio; Arnold Guyot, of Princeton, N. J.; L. Lesquereux, of Columbus, Ohio; E. Billings, of Montreal, Canada; E. Jewett, of Albany, N. Y.; and W. C. Minor and Frank H. Bradley, of New Haven. Mr. Bradley has given freely his constant assistance during the progress of the volume through the press."

The work is divided into four parts. Part I, Physiographic Geology. Part II, Lithological Geology. Part III, Historical Geology. Part IV, Dynamical Geology.

To assist those not familiar with Zoology, a review of the classification of animals, with many illustrations, is given before entering upon the History of the ancient life of the world.

By printing the details in a finer type the book has been adapted to two classes of students—the literary and scientific. The convenience of a literary class has been further provided for by the addition of a brief synopsis of the work in which each head is made to present a subject, or question for special attention. A catalogue of American localities of fossils is also in the Appendix and will greatly aid the researches of young collectors.

The printer, publisher, and engraver have each done their best to make this volume attractive and useful. The wood-cuts in particular are of unusual excellence, and show the value of condensation and good taste in arrangement in saving space, the wonder being that over one thousand figures can be so compendiously and clearly exhibited. S.

2. *Contributions to the Ethnography and Philology of the Indian Tribes of the Missouri Valley.* By Dr. F. V. Hayden. 230 pages, 4to, with a map and two plates. From the Transactions of the American Philosophical Society, 1862.—We have received a separate copy of this important memoir, which forms Part 2d of the XIIth vol. of the Transactions of the American Philosophical Society. Dr. Hayden has enjoyed

excellent opportunities for the study of the languages and habits of our North American Indians, while engaged in the geological exploration of the Upper Missouri. Our readers will recall his article on the Mandan Indians on page 57 of this volume. The contents of the present memoir, after an introduction, embrace the following subjects:

ALGONKIN GROUP, A.

II. Knisteneaux, or Crees—Ethnographical History; III. Blackfeet—Ethnographical History; IV. Remarks on the Grammatical Structure of the Blackfoot Language; V. Vocabulary of the Sik-si-ká, or Blackfoot Language; VI. Shyennes—Ethnographical History; VII. Remarks on the Grammatical Structure of the Shyenne Language; VIII. Vocabulary of the Shyenne Language.

ARAPOHO GROUP, B.

IX. Arapohos—Ethnographical History, and Remarks on the Grammatical Structure of their Language; X. Vocabulary of the Arapoho Language; XI. Atsinas—Ethnographical History and Vocabulary.

PAWNEE GROUP, C.

XII. Pawnees—Ethnographical History and Vocabulary; XIII. Arikaras—Ethnographical History and Vocabulary.

DAKOTA GROUP, D.

XIV. Dakotas—Ethnographical History and Vocabulary; XV. Assiniboins—Ethnographical History and Vocabulary; XVI. Aub-sá-ro-ke, or Crow Indians—Ethnographical History, with Remarks on the Grammatical Structure of their Language; XVII. Vocabulary of the Aub-sá-ro-ke, or Crow Language; XVIII. Minnitarees—Ethnographical History and Vocabulary; XIX. Mandans—Ethnographical History; XX. Observations on the Grammatical Structure of the Mandan Language; XXI. Vocabulary of the Mandan Language; XXII. Sketch of the Omá-ha, and Iowa or Oto Indians, with Vocabularies.

Fifty copies of this memoir were printed at the author's expense, which he desires to dispose of at two dollars per copy. Those desiring the work can obtain it by addressing Prof. S. F. Baird, Assistant Sect. Smithsonian Institution, Washington, D. C.

3. *Transactions of the American Philosophical Society*, held at Philadelphia, for promoting useful knowledge. Vol. xii, new series. Parts I and II, pp. 461. Philad., 1862.—The contents of this volume are,

Article I. On the Geology and Natural History of the Upper Missouri; with a map. By F. V. Hayden, M.D. pp. 1–218.

II. Experiments and observations upon the Circulation in the Snapping Turtle (*Chelonura serpentina*), with especial reference to the pressure of the blood in the arteries and veins. By P. Weir Mitchell, M.D. pp. 219–230.

III. On the Ethnography and Philology of the Indian Tribes of the Missouri Valley; with a map and plates. By F. V. Hayden. M.D. pp. 231–461.

It will be seen from the above titles that much of the substance of this volume has already appeared in this Journal in the various papers of Dr. Hayden which we have published. The Philosophical Society well maintains the objects for which it was founded, "for promoting useful knowledge."

4. *Annual Report of the Board of Regents of the Smithsonian Institution for* 1861: Washington, D. C., 1862. 8vo, pp. 463.—In his Report to the 'Board' as Secretary of the Smithsonian, Prof. Henry remarks:

"It could scarcely be expected that during the existence of an intestine war, and almost in the presence of two contending armies, the Institution should be able to conduct its affairs with the same persistence and success as in the tranquil years of its previous history. The interruptions and embarrassments, however, although frequent, and in some cases perplexing, have not prevented the continuance of the general operations of the Institution, or the prosecution of most of the special objects which had previously been determined upon as falling within the scope of the plan of its organization."

However this may be we are struck in examining this report with its great interest as a record of the progress of science as well as an index of the value of the important achievements made by the Institution itself in furtherance of the benificent design of its founder to "increase and diffuse knowledge among men."

The Report of the Secretary addressed to the Regents, reviews the present condition of the fund, the income of which has been diminished by non payment of interest on about $60,000 of bonds of disloyal states, while a substantial addition to the fund has occurred of about $25,000 from the falling in of an annuity heretofore paid to a relative of Smithson, now deceased. While the active operations of the Institution will not be curtailed by the existing state of civil war, no new undertakings of magnitude will at present be begun. The Secretary, as is his custom, reviews the contents of the publications of the Institution for the year, giving an analysis of the concluding paper, discussing the results of Dr. Kane's Arctic observations, and of a series of papers on the meteorological observations made during the voyage of Sir F. L. McClintock in search of Sir John Franklin in the Fox—1857–1859. These papers form part of the XIIIth volume of the "Contributions."

The *Miscellaneous Collections* include works intended to facilitate the study of the various branches of natural history, to give instruction as to the methods of observing natural phenomena, and a variety of other matter connected with the progress of science. Very properly, in view of its great value as a key to the accurate study of Geology, the Smithsonian has published a series of valuable works on Conchology. They are five in number as follows, viz.:

1st. Elementary introduction to the study of conchology, by P. P. Carpenter, of England.

2d. List of the species of shells collected by the United States exploring expedition, by the same author.

3d. Descriptive catalogue of the shells of the west coast of the United States, Mexico, and Central America, by the same author.

4th. Bibliography of North American conchology, by W. G. Binney.

5th. Descriptive catalogue of the air-breathing shells of North America, by the same author.

The Secretary announces that the illustrations presented from the wood cuts of the British Museum Catalogue by Dr. Gray, and designed to illustrate Dr. Carpenter's Elementary introduction, are now ready for distribution to all who have the work in a separate form.

The Smithsonian is also engaged in developing the history of American Entomology in a thorough and systematic manner, the details of which are given in the Secretary's report.

Ethnology also receives particular attention and a large number of collaborators are engaged in working up this department of knowledge on which indeed the earlier volumes of the Contributions are particularly full.

The system of meteorological observations inaugurated by the Smithsonian at the outset of its career is still maintained and the 2d volume of the Observations is nearly ready to be issued. The state of war has seriously impaired the receipt of records from the states in rebellion and to a good degree too broken up the system of returns from the military posts of the Pacific coast.

The magnetic instruments sent to Key West have been constantly observed and the photographic records uninterruptedly kept up in spite of their nearness to the seat of war, at the joint expense of the Smithsonian and Coast Survey.

Under the heads of Laboratory, Explorations, Collections of Natural History, Museum, Exchanges, Literary, Gallery of Art, and Lectures, valuable information is given for which unfortunately we have not space.

Since the rendering of the last report two of the Regents have died and the present volume contains eulogies on Prof. C. C. Felton by Dr. Woolsey of Yale College, who was elected his successor, and also on Hon. Stephen A. Douglass by his successor Hon. Samuel A. Cox, of the House of Representatives of the United States.

The General Appendix contains a number of voluable memoirs, some of them prepared for the Report by their authors, others translated from the French or German. These are preceded by an abstract of the Lectures given before the Institution, by their authors. We subjoin the contents of this Apppendix.

Lectures.—On the Construction of Bridges, by Prof. F. Rogers. On the Relations of Time and Space, by Prof. S. Alexander. On Arctic Explorations, by Dr. I. I. Hayes.

Memoir of Geoffroy Saint Hilaire, by M. Flourens.*

The Sun: Its Chemical Analysis, by Auguste Laugel.

Progress of Astronomical Photography, by Dr. Lee.

Small planets between Mars and Jupiter, by Prof. Lespiault.*

Scintillation of the stars, by C. H. Dufour.

Synthetical Studies and Experiments on Metamorphism and on the formation of Crystalline Rocks, by M. Daubrée; translated for this Report by T. Eggleston.

Report on Nitrification, by Dr. B. F. Craig.

Notes on the history of Petroleum or rock oil, by T. Sterry Hunt.

Explosibility of coal oils, by Z. Allen.

Destructive effect of iron rust.

Archæology.—Lacustrian Cities of Switzerland. Fauna of Middle Europe during the Stone Age. Report upon the Antiquarian and Ethnological Collections of the Cantonal Museum at Lausanne. Report to the Commissioners of the Museums of the Canton of Vaud on the Researches made at Concise. Ancient Mounds at St. Louis, Missouri. Instructions

* Translated for this Report by C. A. Alexander.

for Archæological Investigations in the United States. Circular on the Ancient Mining Operations of the Lake Superior Copper Region. Suggestions relative to an Ethnological Map of North America.

Natural History.—List of Birds of the District of Columbia, by E. Coues and D. W. Prentiss.

Prize Questions of Scientific Societies.—Holland Society of Science at Harlem. Batavian Society of Experimental Philosophy at Rotterdam. Society of Arts and Sciences at Utrecht. Royal Academy of the Netherlands.

We have to thank Prof. Henry for bringing together for convenient reference the lists of Prize Questions of scientific societies. We do not know where else to look for this information at one view and beg leave to suggest to the distinguished Secretary of the Smithsonian that this list be continued in future Reports and *extended* to embrace a yearly list of *all the prize questions* tending to the advancement of knowledge (not merely 'science' in a technical sense) which may be proposed anywhere. We know of no more acceptable service which the Institution can perform. We give in this connection a passage from a letter of a valued correspondent who speaking on this subject says:

"It is now far from easy for any one who may happen to live outside of the respective bailiwicks of the societies in question to ascertain what premiums are offered even by such prominent bodies as the Royal Society or the French Academy, while the programmes of many active societies like the Soc. d'Encouragement, the Soc. Industrielle de Mulhouse, and several of the other provincial societies of France, together with many in Germany, are certainly not known to one in a hundred of the persons competent, and likely to contend for, the proffered prizes. A remark which would also probably be nearly true with regard to some of our American prizes—like the Rumford medal, for discoveries in light and heat, of the American Academy; if not others like the medical premiums of Fiske and Boylston.

The offer of prizes is important not only in affording an incentive to laudable ambition, in tending to bring out talent and labor which would otherwise lie dormant and be lost to mankind, but the more especially, as it seems to myself, in affording indications to young experimenters of the paths to be chosen,—of the subjects to be worked upon, by them. For the questions are propounded, for the most part, by committees composed of trained specialists,—of eminent men peculiarly fitted to point out the actual desiderata of the branches of science or art with which they are occupied.

Having always believed that a prominent reason why several of the prizes in question have been so seldom taken is to be sought for in the lack of publicity which has attended their announcement, I am especially desirous of seeing a trial of the plan just proposed, during a decade or two at least. I cannot but believe but that it would prove to be a valuable aid to the progress of science.

5. *Journal of the Academy of Natural Sciences of Philadelphia.* New series, Vol. V, Part II. Philadelphia: printed for the Academy, Oct., 1862. 4to, pp. 111–216, with 33 plates.—The contents of this part are:

Art. III. Monograph of the fossil Polyzoa of the Secondary and Tertiary Formation of North America. By William Gabb and G. H. Horn, M.D.

Art. IV. Description of new birds from Western Africa in the Museum of the Academy of Nat. Sci. of Philadelphia. By John Cassin.

Art. V. New Unionidæ of the United States and Arctic America. By Isaac Lea.

The Academy of Natural Sciences nobly maintains its prominence among the publishing Societies of the United States, surpassing them all in the beauty of its quarto Journal and of the numerous plates with which its articles on natural history are illustrated. We are particularly struck with the drawings (on stone by Ibbotson from Gabb's originals) illustrating the fossil Polyzoa, which for perfectness have not been surpassed.

We are reminded by the appearance of Mr. Lea's paper in this Part of our neglect to notice at the time of its arrival his—

—4. *Observations on the genus Unio, &c.;* by ISAAC LEA, LL.D., &c., with 18 Plates, Vol. VIII, Part II, Feb., 1862, read Nov. 12, 1861, pp. 57–115. Mr. Lea's papers on the Unionidæ and other fresh water genera are too well known by all students of malacology to require any extended notice at our hands. As far back as March, 1860, Mr. Lea stated (*Proc. Phil. Acad.*, March 13, 1860) that the number of species described or known to exist in this department was as follows: Unio 465, Margaritana 26, Anodonta 59 = 550, to which he added as not yet described in his own cabinet 30; and for North America, known to inhabit Mexico, Honduras, Central America, and *one* in Canada—Unio 29, Anodonta 8 = 37, making the grand total at that date 617. Since then he has added the contents of the two papers now noticed.

OBITUARY.

Death of General O. M. MITCHEL.—Science mourns the sudden death, by yellow fever, of the patriot-soldier and eminent scientist, Major General ORMSBY MCKNIGHT MITCHEL, which occurred at Beaufort, S. C., on the 30th of October.

He had just entered, with his accustomed zeal and energy, upon the arduous duties of this difficult Military Department, when he fell a sacrifice to that fearful scourge, the general absence of which among our armies on the southern coast has been among the most noticeable hygienic facts of the campaign.

General (Prof.) Mitchel was born on the 28th of August, 1810, in Union County, Kentucky. His early life was checkered; and his love of learning made the boy the father of the man, even before the period of adolescence. He graduated as a cadet at West Point Military Academy in 1829, where he served for two years after, as Assistant Professor of Mathematics. He subsequently studied and practiced law in Cincinnati, and in 1834 accepted a chair of mathematics and astronomy in the Cincinnati College, which he held until 1844. He aided the development of the Railway system of Ohio, by constructing two of the most important lines of Railway in that State.

"The Cincinnati Observatory owes its existence to the labors of Prof. O. M. Mitchel. In the years 1841 and 1842, a society was organized in Cincinnati, called the Cincinnati Astronomical Society, the object of which was to furnish the city with an observatory. Eleven thousand dollars were subscribed in shares of twenty-five dollars; and a site for the observatory was given by Nicholas Longworth, Esq. It consists of four acres of ground, on one of the highest hills on the eastern side of the town. In June, 1842, the society being fully organized, Professor

Mitchel visited Europe to purchase a telescope. At Munich, he found an object glass of twelve inches aperture, which had been tested by Dr. Lamont, and pronounced one of the best ever manufactured. This was subsequently ordered to be mounted, and was purchased for $9,437. This instrument arrived in Cincinnati in February, 1845. In November, 1843, the corner-stone of the observatory was laid by the venerable John Quincy Adams. The building is eighty feet long and thirty feet broad."*

Here, as Director, he afterwards perfected his well known system of Astronomical Observations, and published for a time the *Sidereal Messenger*, the first exclusively Astronomical Journal in the United States. His method of recording right ascensions and declinations by aid of electro-magnetism, to within $\frac{1}{1000}$th of a second of time, is well known to astronomers. He devoted much time to the determination of the velocity of the magnetic current in a long series of transit measurements for differences of longitude in connection with the U. S. Coast Survey. He remeasured Struve's double stars south of the equator, resolving many not before marked as double or triple. The exact period of rotation of Mars and the companion of Antares are also among his discoveries. He retained connection with this Observatory to the last; while in 1859 he was also made Director of the Dudley Observatory at Albany. His "Planetary and Stellar Worlds" and his "Popular Astronomy" are among the best known of his writings.

Probably no discourses on so abstruse a science as astronomy ever created such an impression on the public mind, as his well remembered lectures in 1859 in the N. Y. Academy of Music, where by the vividness of his descriptions—using no diagrams but such as he described in the air by a wand—he held vast audiences in the most wrapt attention, unaided by any of the usual accessories of scientific demonstration. The same impassioned eloquence moved his hearers, when the peril of his country, led him to abandon the Observer's chair and his equatorials to direct armies. The record of his remarkable military exploits belongs elsewhere. Suffice it to say that dying he leaves a record as brilliant in arms, as has been his career in other and more peaceful pursuits.

Newton Spaulding Manross.—We have also to record the loss by this war of another of our respected collaborators whose name has often appeared in these pages—Newton Spaulding Manross, Ph.D., acting Professor of Chemistry at Amherst, was killed in the battle of Antietam, September 17th, while gallantly leading a charge at the head of his company in the 16th Connecticut Volunteers.

Dr. Manross was a graduate of Yale College in 1849, and took the degree of Doctor of Philosophy at Göttingen in 1852. Geology and mining engineering were his special pursuits. He has been much occupied in the exploration of the Isthmus of Panama with reference to the proposed section of that neck of land by an interoceanic canal. His description of the Pitch lake of Trinidad, which he visited in 1855, will be found in vol. xx, p. 153 of this Journal. His Inaugural Thesis 'on the Artificial Production of Minerals' will also be recalled for its merits.

* Loomis's History of Astronomy in the United States, p. 452.

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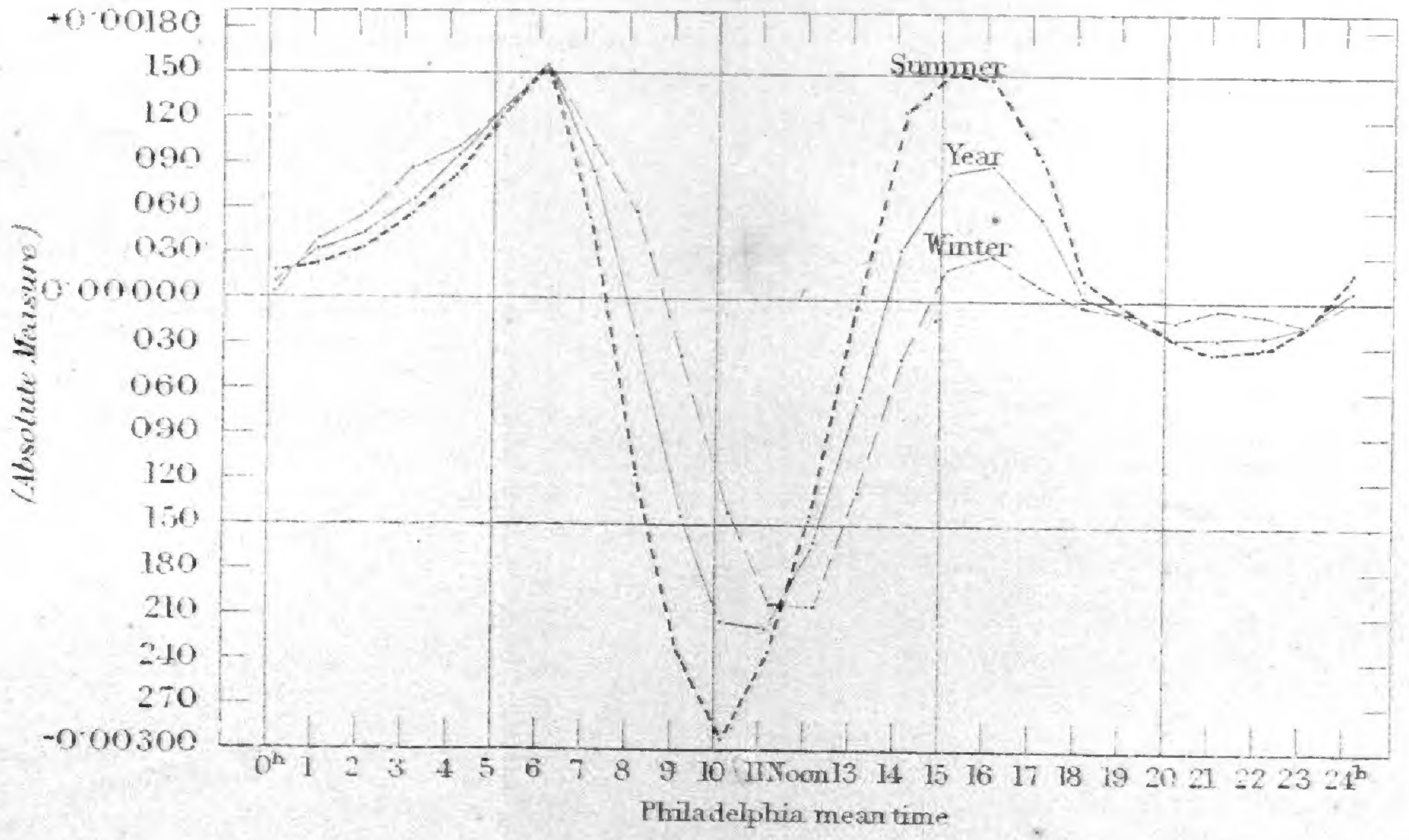
IN 1840 41 42 43 44 & 45 DIAGRAMS TO PART V. 1862 A.D. BACHE LL.D. SUPERINTENDENT

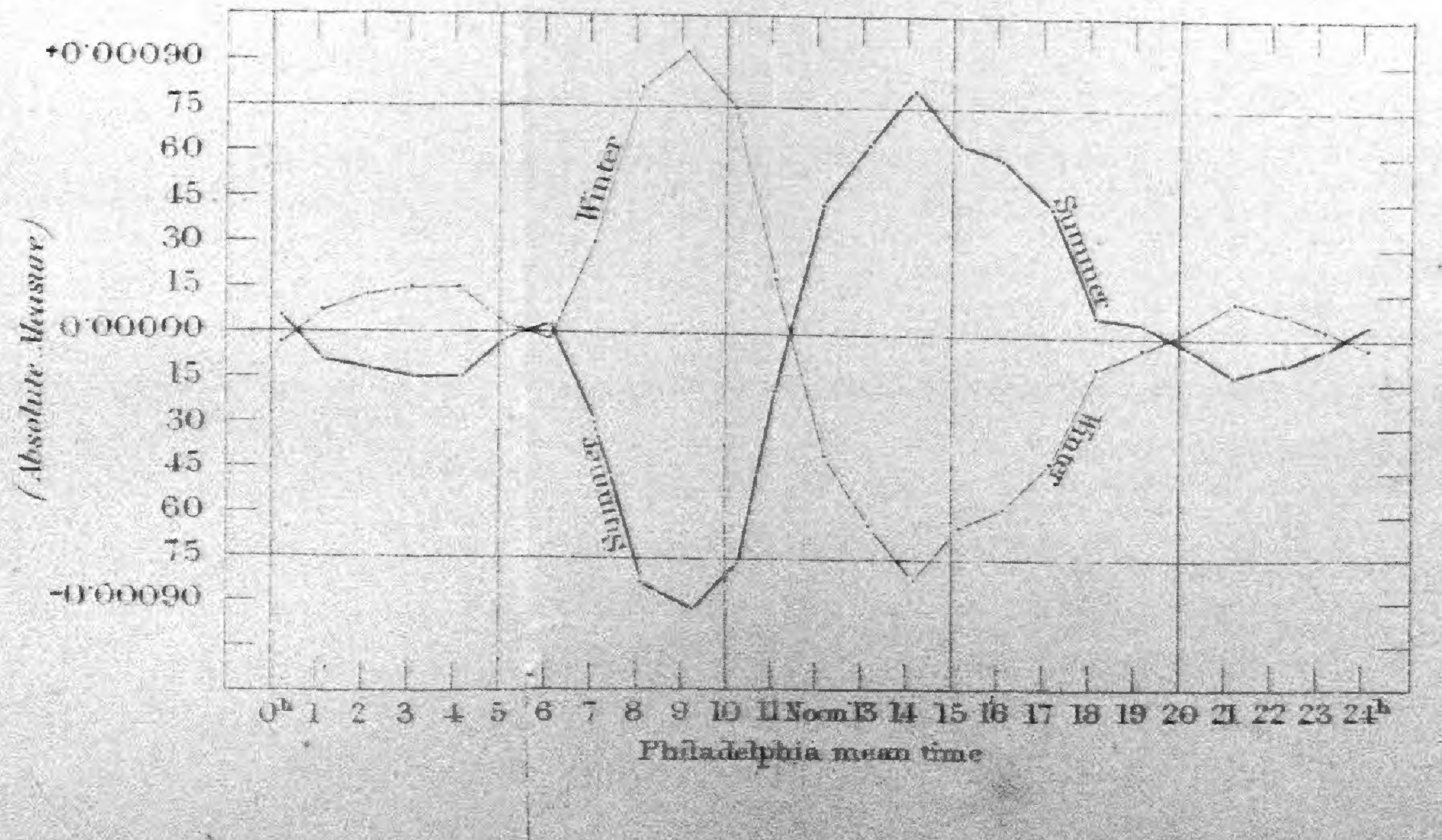
A

Diurnal variation of the Horizontal force in Summer Winter and for the whole year



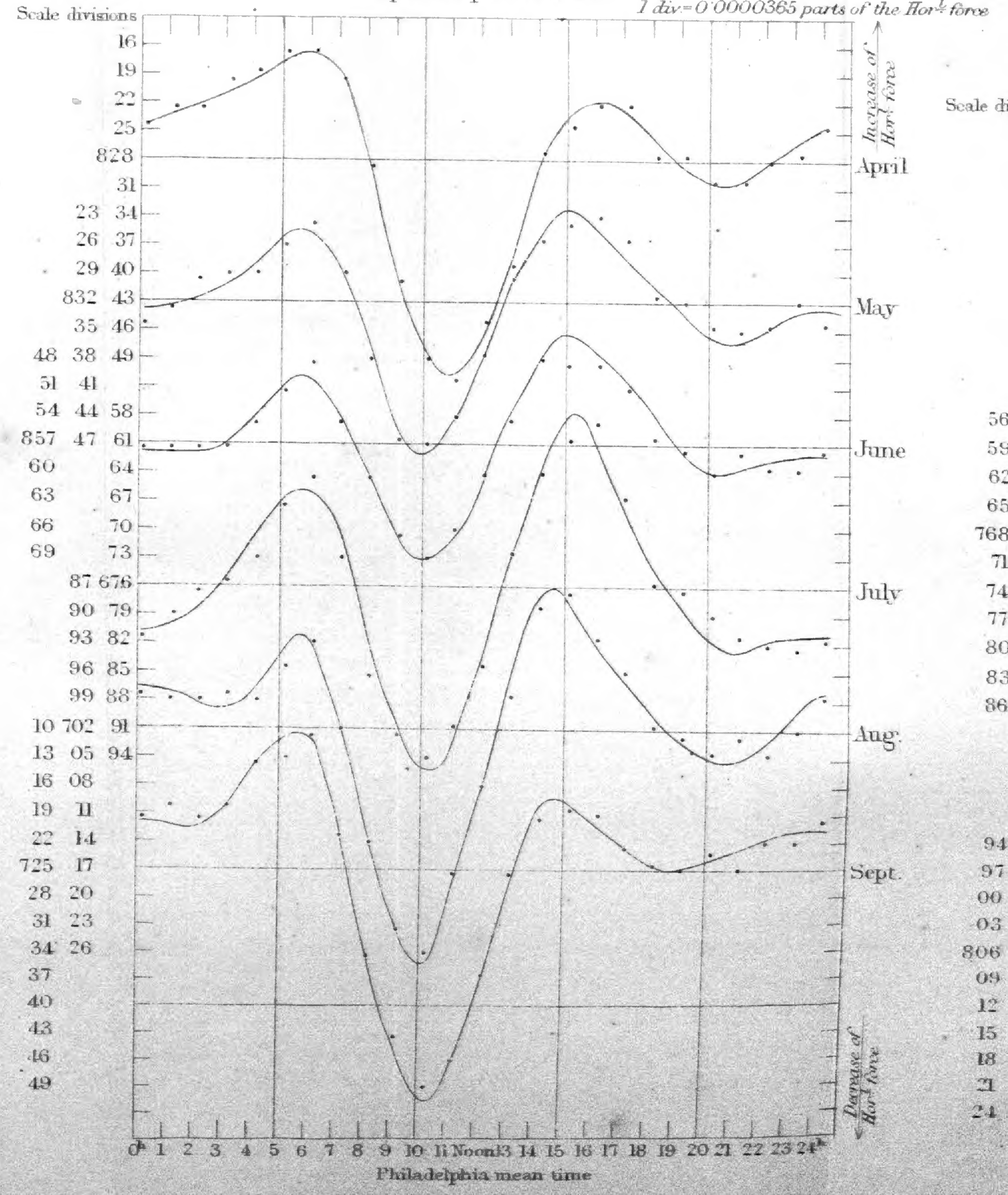
B

Semi-annual inequality in the diurnal variation of the Horizontal force



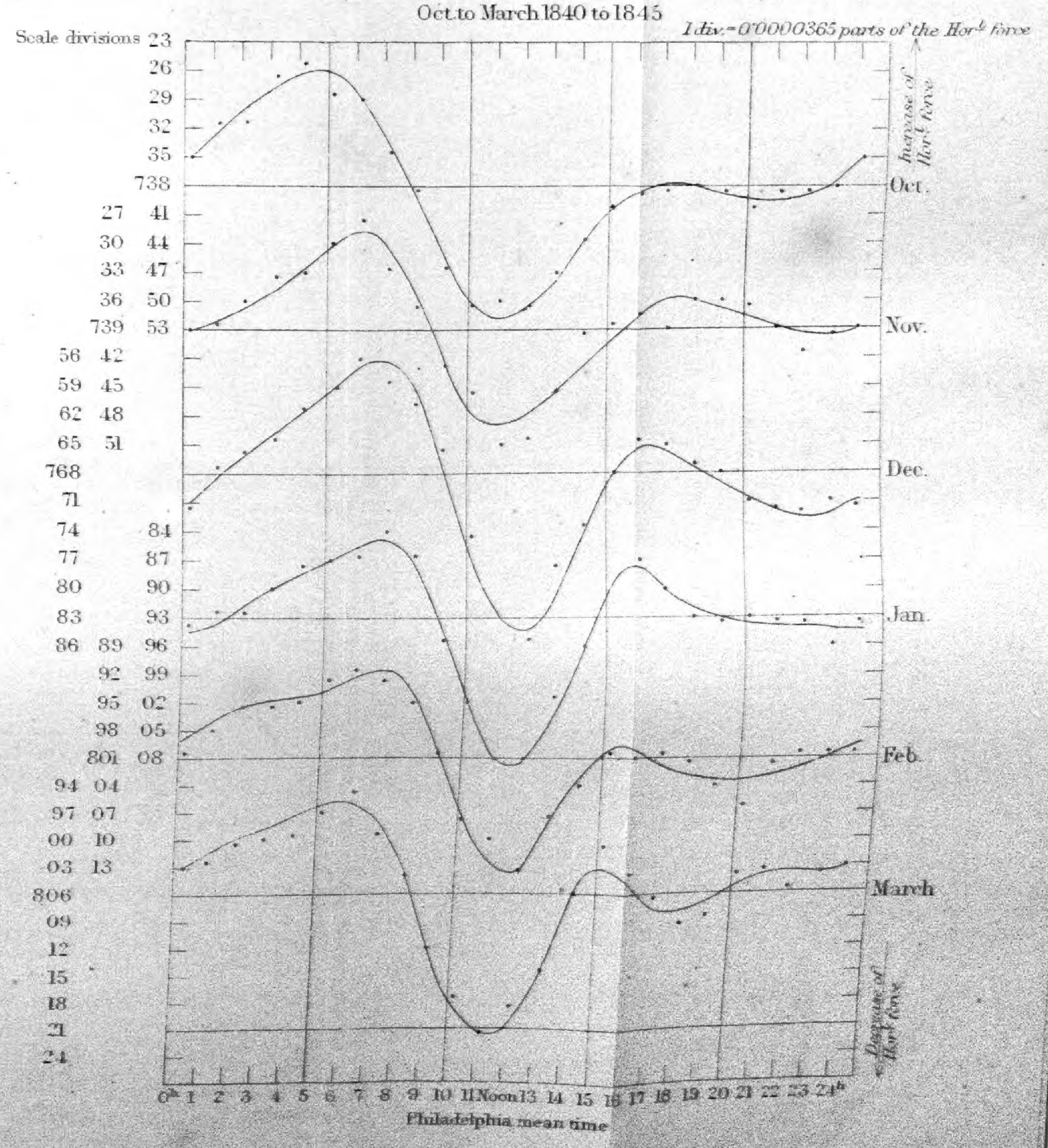
C

Solar-diurnal variation of the Horizontal force April to Sept. 1840 to 1845



D

Solar-diurnal variation of the Horizontal force Oct. to March 1840 to 1845



DISCUSSION OF THE MAGNETIC AND METEOROLOGICAL OBSERVATIONS MADE AT THE GIRARD COLLEGE PHILADELPHIA

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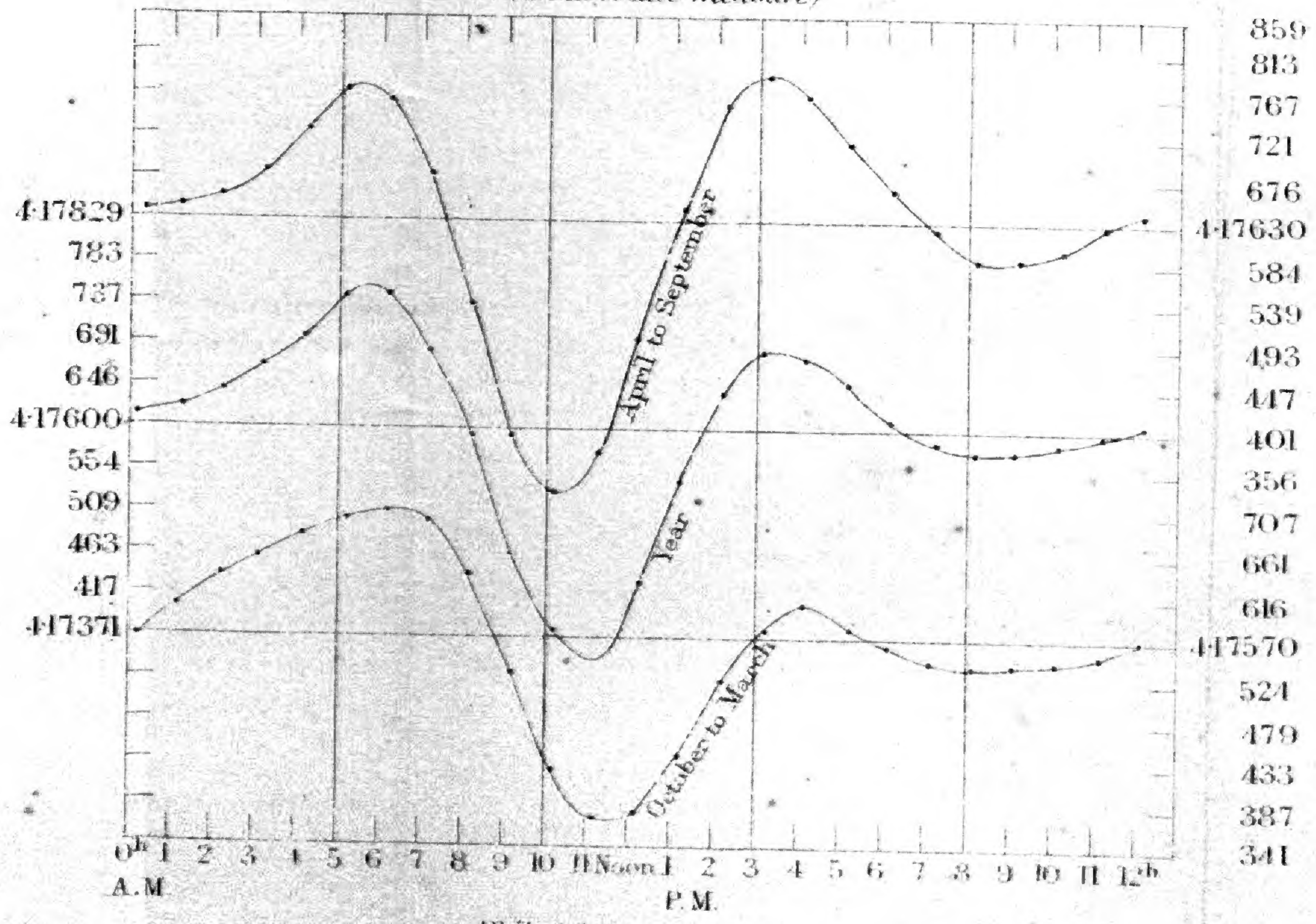
(Continued)

E.

Regular Solar-diurnal variation of the Horizontal force in Summer, Winter and the whole year

(In absolute measure)



G

Changes of the Horizontal force from it's normal value for each hour of the day and month of the year. Expressed in absolute measure

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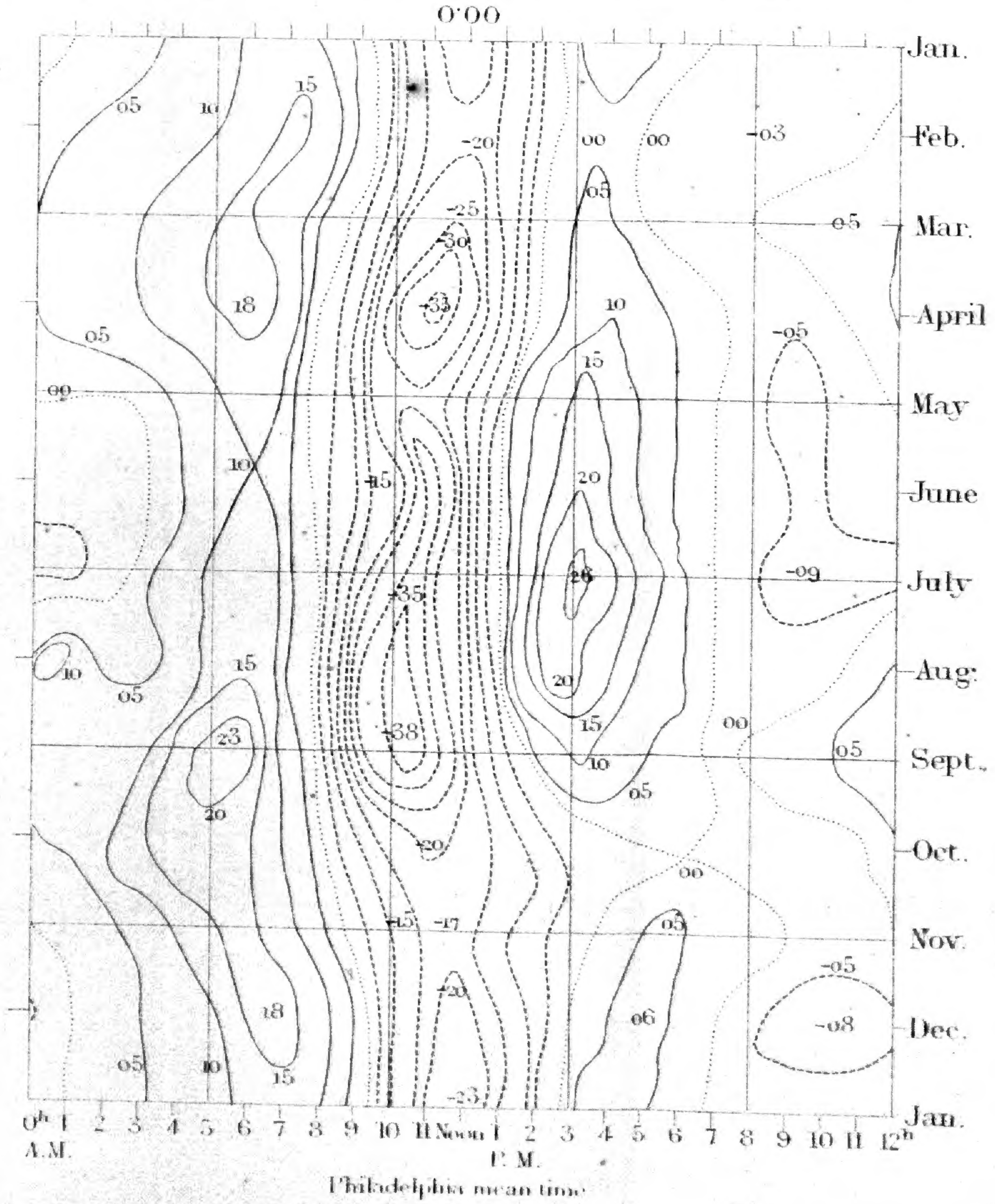
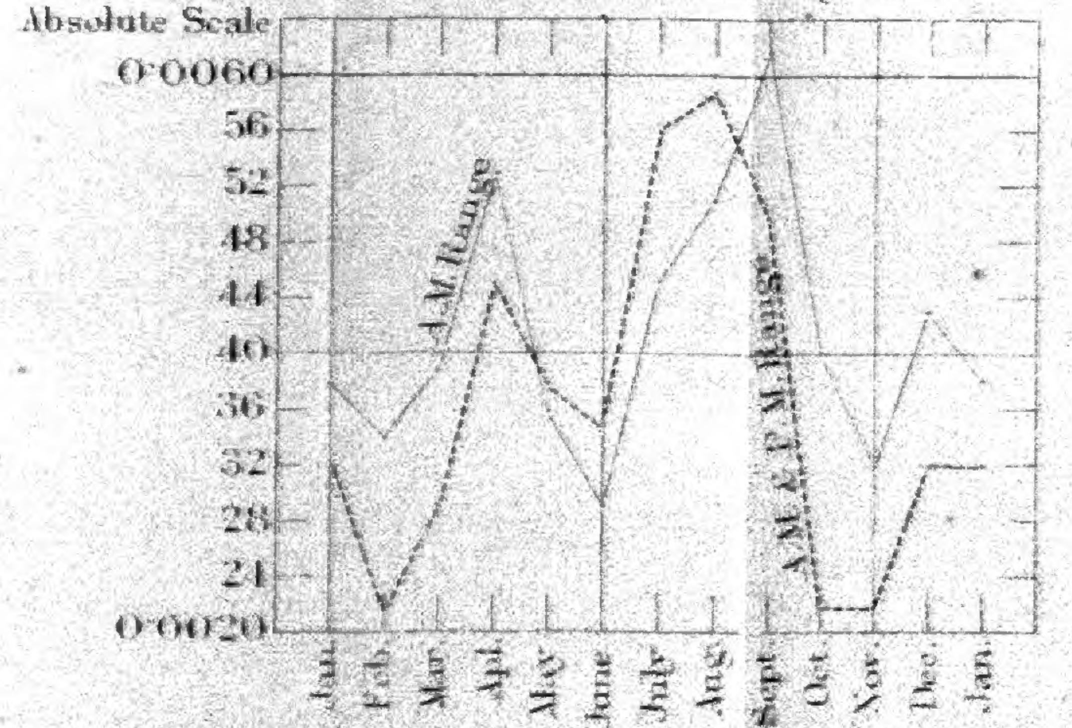


F

Solar-diurnal range of the Horizontal force for each month of the year



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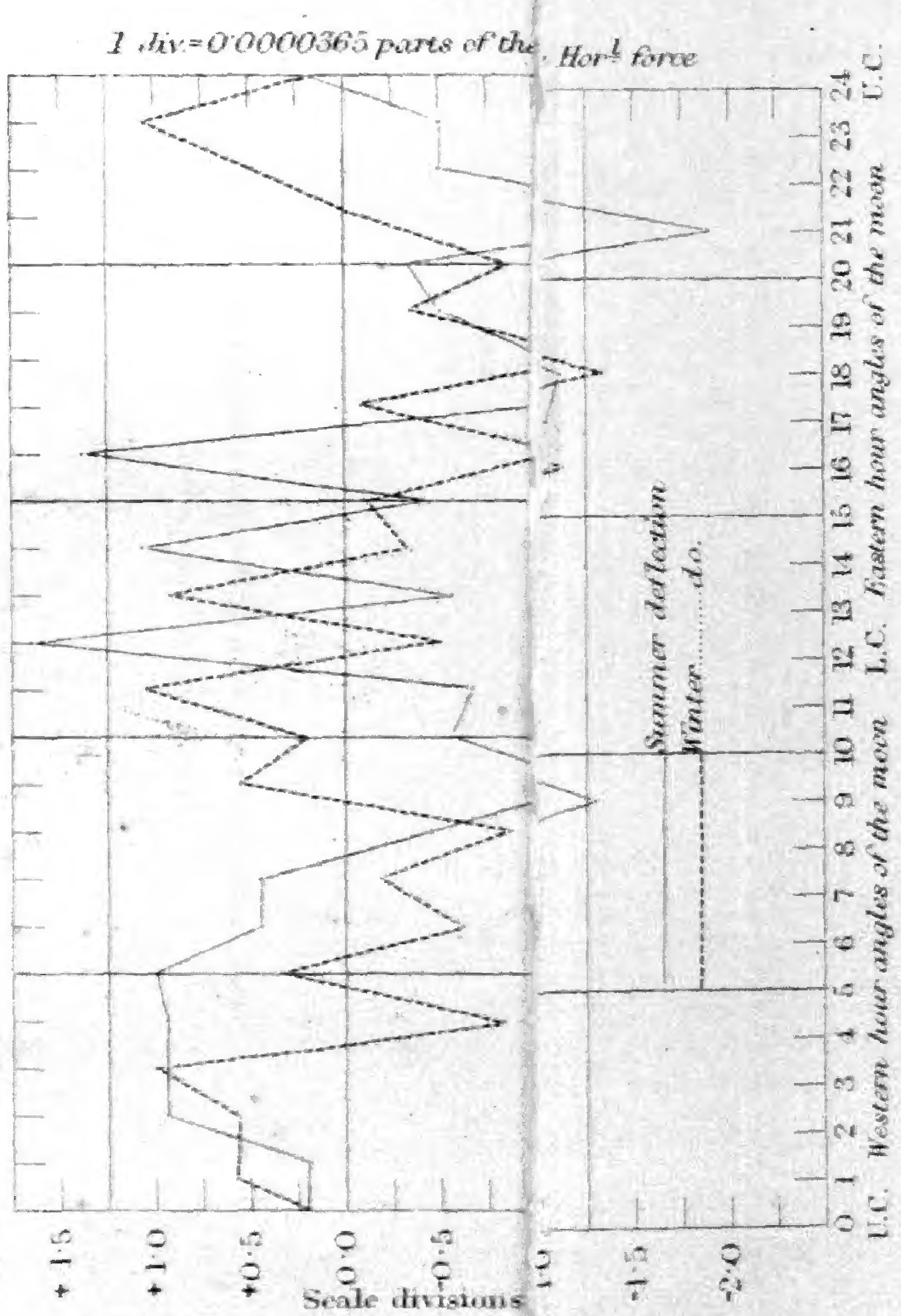
DIAGRAMS TO PART VI.

1862

A

Lunar-diurnal variation of the Horizontal force in Summer and Winter



B

Lunar-diurnal variation of the Horizontal force observed and computed